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VOLUME V

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THE INDUSTRIAL PROBLEM IN AUSTRALIA.

By Edmund Mitchell, M. A.

IN no part of the world has the struggle between organized labor and organized capital been more severe, determined, and continuous, during the past five years, than in Australia. There has been no actual bloodshed, as in the case of the Homestead strikes in America; but there have been present most of the other elements of war,—bitter animosity, ceaseless vigilance engendered by mutual distrust, fierce recrimination, widespread distress and ruin, involving not merely the combatants but thousands of innocents as well. Besides skirmishes of minor importance, there have been four pitched battles, for the fighting of which all the resources of the opposing bodies have been concentrated. First the unionist miners in the coal district of Newcastle tried conclusions by declaring a strike; then the sailors and firemen threw up their work, and dragged into the dispute the wharf-laborers, gas-stokers, shearers, and other associated trades; next the shearers did battle on their own account throughout Queensland, New South Wales, and South Australia; and finally at Broken Hill, the last and best munitioned stronghold of the New Trade-Unionism in Australia, the Amalgamated Miners' Association rushed headlong into a fourth conflict with the employers.

It has to be noted that in no single instance did these disputes originate from or hinge upon a disagreement as to wages. Brushing aside a few minor issues involved, we find that the one cause of quarrel throughout was the demand on the part of the strikers for the exclusive recognition of unionism and the firm determination of the employers to refuse to concede that demand. Had the

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unionists won the day, there can be no doubt that every worker in Australia earning his living by the sweat of his brow would have been compelled to join one or other of the labor organizations and place himself under the domination of the small cliques of individuals in the big cities who make of labor agitation an exhilarating and lucrative profession. As it was, the employers were fighting with their backs to the wall, for the exclusive employment of trade unionists involved the inevitable sequel of trade-union control of the workshops, factories, wool sheds, steamers, and mines; therefore, every individual consideration had to be sunk in the combined determination to win. And they did win, leaving the trade-union bodies at present disintegrated, their accumulations of money dissipated, their leaders thoroughly discredited. The two main results brought about by the five years of incessant fighting count heavily against the trade-union organization. These are, firstly, vast combinations of employers prepared at a moment's notice to waive every selfish consideration and act loyally together as one man; and, secondly, a fixed determination among all classes of the community that the principle of freedom of contract, or the right of every man to earn his living whether he be a trade-unionist or not, shall be maintained at all hazards.

To show how thoroughly labor militant in Australia has forced employers to combine in self-defence, let me take the great wool-growing industry, which adds yearly to the wealth of these colonies from £20,000,000 to £25,000,000. The lethargy and lack of cohesion among the pastoralists enabled the shearers' union three years ago, to acquire a position of almost despotic power. Its leaders boasted that they controlled the shearing in 95 per cent. of the wool-sheds. In the framing of the rules which regulated in every detail the manner in which the shearing was to be conducted, the employer had no voice whatever; he had either to accept them or to enter upon the almost impossible task of fighting the whole union single-handed. Every shearer was compelled to take out his union ticket, paying, besides entrance fees, £1 per annum for the privilege; and the man who refused to submit to this blackmailing process was declared a pariah by whose side no unionist would work or eat, was hounded from wool-shed to wool shed without the chance of securing employment, and was finally driven out of the industry. The weapon of the boycott was ruthlessly used against employers and non-unionist shearers alike, and some conception of the wide-reaching development of the system will be de-

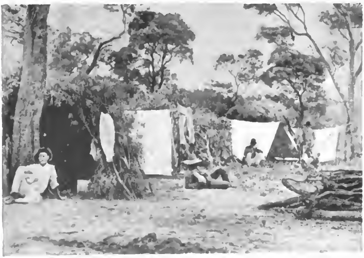
SHEARERS' CAMP, CENTRAL QUEENSLAND.

rived from an extract from a manifesto issued by the shearers' union: "We intend," ran this official document, "to teach the squatter the folly of resistance to our combination. He shall not be allowed to shear his wool except by union labor. But if he should succeed in getting the wool off the sheep's back, it may rot in his sheds, for we shall prevent the carriers taking it to the railway; and should he succeed in getting it to the railway, we shall prevent it going to sea, for we shall call out the sailors and the officers; and if it sails, we shall prevent its discharge in London, for we shall call out the dock-laborers."

This announcement on the part of the trade-unionists of their deliberate intention to inflict a reeling blow upon the great staple producing industry of Australia for no more important reason than that a single back-block squatter might have refused compliance with the unionist demands was the death-blow to the New Trade-Unionism in these colonies. It effectually ranged public opinion upon the other side, and, when the actual attempt to enforce the threat was made, the shearers' union found itself face to face with a combination of pastoral employers infinitely stronger than that of the workmen. The lesson had been driven home to the minds of the pastoralists that employers, when taken in detail, fall an easy prey to organized labor, and that the only safety of each is the union of all. Despite the vast area of the Australian continent and the isolated position of each wool grower, the movement spread from colony to colony, until in a surprisingly short space of time the combination of pastoralists had secured the control of not far short of one hundred millions of sheep. By combined action on the part of the pastoralists' association with the shipowners the attempted boycott on wool was broken down almost instantly, and every bale of wool sent forward was shipped with no appreciable delay.

The shearers' union leaders considered themselves repulsed but not beaten, however, and the very next season (1891) they engineered a strike of shearers throughout Queensland and New South Wales. The bitter and costly struggle thus initiated lasted over six months; but the pastoralists won the fight right from the commencement, for free laborers were poured into the districts where the unionists terrorized the local men from working, every sheep belonging to members of the pastoralists' association was shorn, and every bale of wool was carried to the ports of shipment. Admittedly the wool-growers took these lessons as to organization from the trade-unionists, and the latter were beaten at their own game.

The great shearers' strike of 1891 is typical of the labor struggles that have been going on in Australia continuously during the past five years, and the illustrations that accompany this paper will



FEDERATION STREET, STRIKERS' CAMP, QUEENSLAND, 1891.

ARMED NON-UNIONISTS, CENTRAL QUEENSLAND STATION.

serve to indicate the truth of my previous remark that, while there was no actual blood-shed, there was a condition of real civil war. At Broken Hill, the greatest silver-mining center in the world, the campaign was conducted last year on very similar lines and with identical results. There was a complete absence of rioting on the Barrier, the crowds with which the mounted troops had to deal being as a rule as orderly as those which annually assemble to witness the trooping of the colors at the Horse Guards in London. But for all that the very worst features of the New Trade-Unionism were disclosed in all their repulsive nakedness during the progress of the Broken Hill strike. The leaders, who are now serving sentences in jail, showed themselves to be professional agitators pure and simple. Possessed of the gift of fluent speech, these men, not miners by calling at all, had foisted themselves upon the workers' associations, and, by the rhetorical trick of inflaming envious passions and stirring up strife between the employers and the employed, had soon attained to positions of personal ascendancy, the toleration of which among large bodies of fairly-educated, self-respecting workingmen is almost incredible. The strike was the very opportunity desired by the leaders. At one bound they became persons of public importance, issuing fierce manifestoes, having their speeches telegraphed across a great continent, visiting their pickets like generals in the field, being huzzaed by the mob as they passed along the streets, and generally living in a constant vapor-bath of self-esteem and servile flattery. All these are simply the necessary preliminaries to securing a seat in Parliament and what to a man of the working classes is a very large income,—£300 per annum, with no real hard work to do, with free railway traveling and invitations to official dinners.

The real workers of the Barrier did not strike of their own free will; they were coerced into doing so by their leaders, who, as I have shown, had their own private ends to serve, and who had at their beck and call a gang of about a thousand of the worst type of larrikins to be gathered together from all parts of Australia. The latter were men who had no honest desire for continuous work, who were not really miners by training, who had been forced upon the mining companies in the first place by the unionist tactics of threatening a strike if any refusal to their demands was made, and who were quite content to live in idleness for a few months at the cost of their fellow workers in the other colonies. Here is the whole secret of the Broken Hill strike, which has

NINE-POUNDER GUN FOR PROTECTION OF NON-UNIONIST SHEARERS.

caused such ruin among the homes of the resident miners, but which has had its good results in driving from the Barrier silver field the riff-raff whose presence was a constant menace to industrial peace.

Prior to this great series of strikes which began at Newcastle and terminated at Broken Hill, the unions were in a position in the various industries affected to compel the employers to employ only unionist workers. The abuse of this power, towards both employers and non-unionist workmen, was flagrant. The trade-unions in Australia had become small oligarchies of labor, appropriating all the wages paid in certain trades, excluding interlopers by a system of prohibitive entrance fees, compelling employers to retain the services of inefficient or mischief-making workmen, and practically taking the whole control of each business out of its owner's hands. But in pursuing this utterly selfish policy the New Unionists over-reached themselves. At the moment of crisis their whole system broke down, for the men they had excluded from their ranks in time of peace stepped in and took the place of the unionist strikers in time of war. It afforded keen satisfaction to the able-bodied laborer, who for months before had vainly sought for work on the wharves of Melbourne, failing to get it simply because he was unable to pay the £5 entrance fee to the wharf-laborers'

LIBRARY IN STRIKERS' CAMP, CENTRAL QUEENSLAND.

QUEENSLAND BUSH WORKERS.

union,—to have a share of the loaves and fishes at strike time. The unionists on strike looked aghast at the spectacle of free laborers taking their places, and they reviled the new-comers as "blacklegs," "scabs," and "traitors." The truth is that the free laborers by their action helped to break up the most unscrupulous and selfish organizations that have ever brought discredit upon the noble cause of trade-unionism. The phrase "freedom of contract," which is purely of Australian origin in this application, having originated during the simultaneous maritime strikes in Melbourne, Sydney, Adelaide, and Brisbane, has now come to be, not merely the watchword of employers, but the charter of liberty for every workingman in these colonies. Workers have no longer to submit to being bailed up for their union ticket before they are allowed to handle a hammer or shift a sack of wheat. Employers are now free to engage their hands solely upon their merits as workmen, and quite irrespective of their being trade-unionists or not. In a word, public opinion demands that no man shall be refused the right to earn bread for his family and himself simply because, from poverty, conviction, or any other motive, he declines to join a trade union. If Unionism is ever to recover its lost position in Australia, it will have to accept, not reluctantly and sullenly as now after bitter defeat, but fully and freely, the principle of freedom of contract. It will have to recognize that, if members of a trade-union have their rights, precisely equal rights are possessed by the men who refuse to surrender their individual liberty, except in so far as that individual liberty is restricted by the laws of the land, passed by the parliamentary assemblies elected to make those laws.

It is difficult to estimate the seriousness of the check that has been given to the development of Australia by the industrial unrest of recent years. Outside investigators, unfortunately, have not paused to reflect that the voice of the trade-unions, like the voice of the cicada, has been out of all proportion to the extent of their organization. It may surprise readers in America or Europe who have been following the labor question in Australia to learn that there are not more than 75,000 unionists in all these colonies. For this fraction of the working population to speak in the name of Australian labor is scarcely less absurd than were the three tailors of Tooley street, who began their famous document with the words: "We, the people of England." It is needless to deny, however, that outside Australia, and even within the colonies, the trade-unions, by reason of their public prominence, have come to be looked upon as synonymous with the working classes generally. The paucity of their numbers, and their antagonism to large sections of men who live by labor, show how mistaken is this notion.

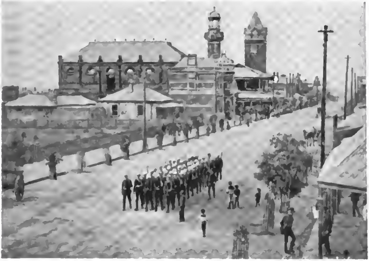
Why, at this moment, in a country whose resources are inexhaustible, is it almost impossible to float public loans? Why has the establishment of new industries and the extension of existing ones been brought to a standstill? Why are millions of pounds sterling being deposited with the Australian banks for investment elsewhere, while the land is crying out for the fertilizing stream of capital? The answer is writ large upon the wall. Investors will not embark their money upon Australian enterprises so long as there exists no guarantee of industrial rest, no guarantee that at any moment contracts entered into will not be upset by a wanton strike, no guarantee that the blind policy of labor grappling at the throat of capital will be abandoned. In a word, the uncertainty of the labor question is paralyzing investment.

A few years of "booming" and wild speculation have been succeeded by the inevitable collapse and period of depression. The whole system of immigration has been misunderstood, and, instead of the new-comers being steadily directed away from the thickly settled districts, as in America, in Australia the four chief maritime cities act as huge drag-nets, intercepting and retaining nine out of every ten new-comers. In consequence, these four centers hold about half of the entire population in each colony, and these armies of town-dwellers thus became comparatively useless manipulators of material already produced in a land where the undeveloped mineral, pastoral, and agricultural resources require every pair of hands that can be found. Without broaching the vexed question of free trade and protection, there can be no doubt that the protective policy of these sparsely populated colonies, directed towards encouraging city industries such as shoe-making, the manufacture of hats, and the turning out of slop goods, is a delusion and a snare. There is an area equal to an English county for every man, woman, and child in the Australias, absolutely unoccupied and undeveloped; yet we have Melbourne with a population of half a million souls, and Sydney almost as densely peopled, and in these cities we meet with poverty and distress and thousands of unemployed vainly seeking for work. Owing to this we find immigration to Australia inveighed against by the trade-unionists who are already in the country but who, remaining in the towns, have done little or nothing to develop its resources; and

THE STRIKE AT BROKEN HILL.

we have even the astounding spectacle of the colonial representatives in London, the agents-general, warning off intending immigrants from a land teeming with natural wealth and capable of supporting, not the four millions of people that now dot its seaboards, but four hundred millions.

No amount of word-painting or piling up of statistics can give even a faint idea of the vast potential wealth of Australia. Full revelation only comes when one travels over the country, and, seeing in patches here and there what the soil is really capable of, finds the land a veritable wilderness with no sign of human occupation except for a few sheep fences. The scrub has only to be rolled, burned off, and tickled with the stump-jumping plow to produce harvests of wheat that cannot be beaten in any part of the world. The vast, perfectly flat area lying between the Murray and the Murumbidgee rivers has a soil rich as that of a garden, but it is given over to sheep, running about one to the two acres and producing about seven shillings' worth of wool per annum. In Queensland, upon the savannahs stretching hundreds of miles in every direction, the traveler rides or drives through natural herbage reaching to his buggy-poles or his saddle girths, and in a day's



GOING ON DUTY AT THE MINES, BROKEN HILL.

journey sees only a few hundred sheep or a few score of cattle. The unbounded productiveness of these waste lands is proved by actual results. Australia can grow meat, butter, cheese, wine, fruit, and wheat for the whole world. From a few butter-factories in Victoria, for example, a single steamer has recently taken away £65,000 worth of chilled butter, and shipments are proceeding upon this scale weekly for three months each season, although it is only within two years past that the export trade in this article was commenced. Victorian brandy has been pronounced by the British medical journals to be equal in quality to the finest French cognac. The results already achieved show almost unlimited possibilities for wine-making in Australia. The fruit trade also has an infinite future, grapes, peaches, apricots, oranges, lemons, pears, apples, plums, pine-apples, and almost every other known variety capable of sea transport flourishing as in the sunniest corners of France, or Spain, or Italy. Then, even the already important pastoral industry is capable of expansion, for an immense area of country is still unstocked, and in the wool growing districts a system of small farming, with cereals and stock dividing the attention of the agriculturist, would vastly increase the productiveness of the sheep runs. The fattening of sheep and cattle for export in the frozen state to the markets of Europe is an enterprise as yet merely in its infancy. The primeval forests in many regions are

EDMUND MITCHELL.

rich in valuable timbers, but their silence is still unbroken by the ring of the woodman's axe. Instead of the three thousand camels now in use in the arid regions of central Australia there might be twenty times that number, opening up pastoral country as yet incapable of occupation through the impossibility of getting up station supplies, and enabling gold reefs to be worked where men cannot now subsist for scarcity of water.

Again, one has but to stand at Bendigo, or Ballarat, or Broken Hill, before the mountains of slag or quartz tailings, to realize that only a pinch of the mineral wealth in the bowels of the earth has yet been extracted. In Tasmania is the biggest tin-mine in the world, Mount Bischoff; in New South Wales the biggest silver-mine in the world, the Broken Hill Proprietary; in Queensland the biggest gold-mine in the world, Mount Morgan; in South Australia, one of the biggest copper mines, Moonta; around Newcastle, in New South Wales, among the most extensive coal measures anywhere to be found. And though hundreds of millions of pounds sterling worth of minerals have been raised in Australia, it is certain that thousands of millions remain to be won. Yet, despite the fact of an over-crowded old world, the flow of immigration to this great new world has all but ceased, and so far as population is concerned Australia, outside a few score of large cities and towns, is virtually a wilderness.

What these colonies want are population and capital; yet we find an utterly selfish growth of trade-unionism doing its utmost to check the inflow of both. "Australia for the Australians!" shout the men who are deliberately allowing harvests of untold wealth at their doors to lie ungarnered. If only the colonial governments would throw aside the last vestige of fear of the Trades' Halls; if only politicians could be found who would think more of the country's development than of the voters in their particular metropolitan constituencies; if only a race of statesmen were to arise who would resolutely burst up the city populations and take measures to pour a steady stream of immigration upon the soil,—then the progress of the Australias would amaze the whole civilized world. Perhaps the sovereign remedy will be found in Federation, which may give us, instead of half a dozen insignificant and time-serving legislatures, one thoroughly disinterested and representative Parliament, to whose service men of honor, education, and enlightenment, who too often shrink from contact with present parliamentary methods, will devote their lives.

A DECADE OF MARVELOUS PROGRESS.

By Richard H. Edmonds.

THE growth of a great country like the United States cannot readily be comprehended except by a study of the aggregate results of the progress of a stated period, say of ten or twenty years. Ten years is but a brief span in the life of a nation, but a study of the history of this country during the ten years ending with 1890 will reveal a growth and expansion that few persons otherwise would have any conception of. Any attempt to estimate the future growth of the country, or to set forth the possibilities of the present decade as indicated by the wonderful advances of the last, would produce statistics that would probably be thought to have come from the brain of a visionary enthusiast. Without venturing any forecast, therefore, an attempt to point out the progress made by the United States in some directions in the last decade may be of interest. From this may be shown what population and production and achievement will be reached in 1900 if the rate of progress maintained from 1880 to 1890 should continue to the end of the century, leaving to the readers of THE ENGINEERING MAGAZINE the privilege of judging whether our national progress will go on at a slower rate or as rapidly as in the past.

In 1880 the population of the United States was 50,100,000; in 1890, admitting the census reports to have been correct, 62,500,000 people lived under the protection of the stars and stripes. The rate of increase was 24.8 per cent. The fact that this was less than for any previous decade in this century caused many to believe that the figures were too small, but, taking it for granted that these figures approximate to correctness, we added to our population in ten years 12,500,000 people. What this means can be best understood by means of comparison with the population of the leading cities of the country in 1890, which was as follows:

CITIES.	Population.	CITIES.	Population.
New York	1,515,000	Milwaukee	204,000
Chicago	1,099,000	Newark	181,000
Philadelphia	1,046,000	Minneapolis	164,000
Brooklyn	806,000	Jersey City	163,000
St. Louis	451,000	Louisville	161,000
Boston	448,000	Omaha	140,000

Baltimore	434.000	Rochester	133.000
San Francisco	298,000	St. Paul	133.000
Cincinnati	296,000	Kansas City	132,000
Cleveland	261,000	Providence	132,000
Buffalo	255.000	Denver	106,000
New Orleans	242,000	Indianapolis	105,000
Washington	230,000		
Detroit	205,000	Total	9,200,000

Thus the increase in our population between 1880 and 1890 as shown by these figures was 3,300,000 greater than the combined population of every city in the United States of more than 100,000 population.

Wealth increased during the decade even more rapidly than the population. It was a period of such gigantic railroad and industrial developments as to have furnished a foundation for the vast gain reported by the eleventh census in the assessed and the true valuation of our property. The assessed value of property in 1890, excluding all railroad property, except in a few States in which it was impossible to separate the latter from other taxable property, was $24,651,585,465, against $16,902,993,543 in 1880,—a gain of $7,748,000,000, or 45.84 per cent. The true valuation of all property in the United States in 1880 was $43,642,000,000. Should it be found upon completion of the census inquiry in relation to the true valuation of property that the same relation existed in 1890 between the assessed valuation and the true valuation as existed in 1880, the absolute wealth of the United States in 1890 was about $63,648,000,000, or a gain of $20,000,000,000 in ten years, not counting the increase in railroad property.

Nothing else tells the story of the marvelous progress of this country between 1880 and 1890 so well as the statistics of our manufacturing and mining interests. In the magnitude of our manufactures we now lead the world, and the annual value of the output of our factories far exceeds the aggregate value of all our farm products. The exact figures are not yet obtainable, as the census report on manufactures has not been completed, but in a recent interview Mr. Robert P. Porter, superintendent of the census, gave approximate estimates. These show that the gross value of our manufactured products during 1890 were about $8,600,000,000, against $5,300,000,000 in 1880,—a gain of $3,300,000,000. The capital invested reached $4,600,000,000, against $2,700,000,000 in 1880. The increase between 1880 and 1890 in the capital invested in manufactures was greater than the entire capital so invested in 1870.

In ten years we added to our manufacturing capital $1,900,000,000, while only twenty years ago—or in 1870—the aggregate manufacturing capital of the country was $1,690,000,000. The wages paid to the employés in manufacturing establishments in 1890 were nearly $1,500,000,000, or $500,000,000 more than in 1880. The number of hands employed increased 900,000 during the decade, so that in 1890 there were 3,600,000 people on the pay-rolls of our manufactories.

If the details of our manufacturing progress be examined, it will be found that there has been a well-rounded growth. Every branch of industry has made large gains. In cotton, in wool, in iron, in lumber, and in all industries using these staples as raw materials, there has been a wonderful advance. The increase has been in the small and large industries alike. We are making more pins and tacks and building more great steamships; we are making more coarse cotton and woolen goods and producing more fine cloths and silks. Every branch of industry that comes between these extremes has grown proportionately. In 1880 the iron-makers of the United States produced 3,781,000 tons of pig-iron, and, as that was a gain of nearly 100 per cent. over 1870, it was regarded as a rapid growth. In 1890, however, they turned out 9,579,000 tons, or a gain of over 150 per cent. in ten years, the total for 1890 being more than 2½ times as great as that of 1880. The actual increase in 1890 over 1880 was 2,000,000 tons greater than the total production in 1880. The 7,100,000 tons of iron ore mined in 1880 increased to 14,500,000 tons in 1890. The total production of all kinds of steel in 1890 was 4,466,000 tons, against 1,100,000 tons ten years before. In 1880 we made 740,000 tons of steel rails, and in 1890 we made 2,036,000 tons. The capital invested in woolen factories increased from $159,000,000 in 1880 to $296,000,000 ten years later.

Keeping pace with manufacturing growth, the mining interests of the country turned out $656,600,000 of products in 1890 against $369,000,000 just ten years before. This gain touched every branch of mining; the production of coal rose during the decade from 63,800,000 tons, valued at $95,600,000, to 140,700,000 tons, valued at $176,700,000; copper from 60,000,000 pounds, worth $11,500,000, to 265,000,000 pounds, worth $30,800,000; petroleum from 26,200,000 barrels, worth $24,000,000, to 45,800,000 barrels, worth $35,000,000; and silver from 30.300,000 ounces to 54,500,000 ounces.

Railroad construction progressed rapidly during the decade. It is difficult to realize that, whereas we now have 170,600 miles in operation, we had only 93,200 miles in 1880. At the end of 1890 we had 166,700 miles,—a gain of 73,500 during the decade, or about 80 per cent. Thirty leading roads, which operated 31,500 miles of track in 1880 and hauled 96,000,000 tons of freight, in 1890 opeerated 76,400 miles and hauled 262,900,000 tons. The number of passengers carried by these roads increased from 58,400,000 to 183,000,000. The number of locomotives on all the roads in the United States increased from 17,900 in 1880 to 32,200 in 1890, and the number of passenger-, freight-, and baggage-cars from 556,000 to 1,092,000. The capital invested in railroads as represented by bonds and capital stock was a little less than $5,000,000,000 in 1880, and a little less than $10,000,000,000 in 1890.

In the decade under review a new industry of vast magnitude was created. Twelve years ago electricity as applied to street-cars, for power purposes of all kinds, for house and street illumination was a new thing. In fact electric street-railroads have only been in successful operation about half of that time. The electrical age was practically just commencing, and the aggregate capital invested outside of telegraphy was small. Now almost every town of any size has its electric railroad, streets everywhere are being lighted by electricity, and electricity furnishes power for factories, to run elevators, and for many other purposes; still we have scarcely seen the beginning of electrical development. Already, however, the capital invested in all branches of this industry—and nearly all invested since 1880—is estimated at $800,000,000.

Our national banking capital increased from $467,000,000 in 1880 to $662,000,000 in 1890, and the deposits in savings-banks from $819,000,000 to $1,550,000,000.

Agriculture is supposed to be the foundation of our progress and prosperity. This is to a large extent true, and yet, while the value of our manufactured products in 1890 was $8,600,000,000, the total value of all agricultural products in that year was only about $3,800,000,000. The opening up of new land by the heavy immigration into the West brought into cultivation ten or more years ago a larger area than the consuming power of this country, and the foreign demand added, justified. In a pamphlet recently published by Mr. C. Wood Davis, it is shown that the area cultivated in staple food-crops increased from 1875 to 1880 on an average of 6.8 per cent. a year, and since then has steadily declined, having been 3.9 per cent. from 1880 to 1885 and then 1.4 per cent.

from 1885 to 1890. In other words the total cultivated area is now increasing much less rapidly than our population. Of course in view of this the agricultural productions of the country do not show any such phenomenal advance as has marked the growth of industrial interests. The total value of all agricultural products in 1880 was estimated at $3,700,000,000. Mr. James R. Dodge, the statistician of the Agricultural department, estimated the value in 1890 at $3,800,000,000,—a gain of $100,000,000,—notwithstanding a heavy average decline in price and very short crops, owing to bad weather. In 1891 large crops brought the total value up to $4,500,000,000. The number and value of farm animals increased very heavily during the decade, the total value having been $1,576,000,000 in 1880 and $2,418,000,000 in 1890,—a gain of $840,000,000.

The facts which have been presented are simply intended to give some conception of the actual progress of this country. The magnitude of its advancement can only be realized when, as we have already said, we sum up what has already been accomplished in a brief period of ten years. To attempt to go into the details of this progress, to show the growth of every branch of industry, to point out the special enterprises of great magnitude that have been undertaken, to name even the most noted of the magnificent winter- or summer-resort hotels costing upwards of $1,000,000 each that have been built at St. Augustine, Tampa, and elsewhere, would be unnecessary in such a paper as this, and yet they all help to impress upon the mind the results accomplished in ten years.

Is there a single good reason why the decade that will end with 1900 should not witness even greater achievements and progress than were seen between 1880 and 1890? There would seem to be none. Wars or pestilences or panics may come, but this country grows right along. They may cause a temporary halt, but that seems only to serve as a resting-spell, to be followed by a still more rapid advance. Our national progress has gone on at a steady rate for many decades, and it is only the magnitude which our population and wealth and business have now reached that makes the statistics that picture the difference between 1880 and 1890 seem so overwhelming. We know that our population increases at an average of about 25 per cent. or over every ten years, that our production of iron has more than doubled every decade since 1840, that our wealth is annually increasing at a rapid rate; we know that we are developing a fine navy, that we are building up an immense domestic shipping business, having now in our lake and coastwise trade 25,540 vessels valued at $215,000,000, which carried in 1890 over 172,000,000 tons of freight; that the beginning has been made in a revived foreign mercantile business, with the letting of contracts for five steamers to cost from $8,000,000 to $10,000,000, and to equal the *Paris* and the *New York;* that within the last few years there have been built the $5,000,000 shipyard at Newport News, the $6,000,000 combined iron- and steel-works and shipyard at Baltimore; that the chief shipyard at Philadelphia is largely the result of development of the last five or six years; that a number of large iron and steel shipyards have been started on the lakes within the last few years, the details of which were so entertainingly set forth by Mr. Henry A. Griffin in THE ENGINEERING MAGAZINE last month. These things we know, and we know that they all point to a broader and more rapid national growth than we have yet seen. An honest investigation will convince even the most confirmed pessimist that our country is advancing in material progress, and also in the arts and sciences, as never before. What amount of development then may we reasonably look for during the present decade? Starting in 1890 with a population of 62,500,000 and allowing for the average increase which has prevailed for a number of decades of about 25 per cent.,—never but once less than that, and then 24.8 per cent.,—it will be seen that in ten years there will be added 15,600,000, giving us in 1900 a total population of 78,100,000. To fully appreciate the magnitude of this gain in population it may be compared with the population of the Southern States in 1890 as reported by the Census:

STATES.	Population.	STATES.	Population.
Maryland	1,042,000	Kentucky	1,858,000
Virginia	1,655,000	Tennessee	1,767,000
West Virginia	762,000	Alabama	1,513,000
North Carolina	1,617,000	Mississippi	1,289,000
South Carolina	1,151,000	Louisiana	1,118,000
Georgia	1,837,000		
Florida	391,000	Total	16,020,000

Thus, omitting Texas and Arkansas, 16,000,000 people lived in the South in 1890, which is but a little more than the actual increase in the population of the United States will be in ten years. Expressed in another way, this increase is equal to the combined population of all the cities and towns of over 8000 population in the United States, excepting New York and Chicago. The total urban population, including these two cities, in 1890 was 18,200,000 The increase already mentioned will be about 15,600,000, or only 2,600,000 less: But as the desirability of limiting immigration is being discussed, it may be claimed that the rate of increase will be less if this be done. Suppose immigration should be absolutely stopped, which is not probable, even then our gain would be about 11,000,000 or 12,000,000,—enough certainly to satisfy our national pride. What this means in city development, in increased demand for all manufactured and farm products, for enlarged railroad facilities, and in fact for everything which tends to national progress, can only be understood by remembering what was required and what was accomplished during the decade between 1880 and 1890.

In the material progress of this country as marked by the production and consumption of iron and steel there is an accelerating rate of growth. The consumption of iron not only increases with the increase in population, but the rate of consumption *per capita* has steadily increased for many years. Should the rate of gain between 1890 and 1900 be as great as between 1880 and 1890, the production of pig-iron in 1900 would be 24,200,000 tons. Should the actual increase in tons only be equal to the actual increase in 1890 over 1880, the total output in 1900 would be 15,370,000; basing their calculations upon the average rate of increase in iron consumption for the last forty years, the Hon. Abram S. Hewitt and Mr. Edward Atkinson estimate that the production of pig-iron in this country in 1900 must be from 17,000,000 to 19,000,000 tons. The 24,000,000-ton figure will probably not be reached. It is scarcely in the range of possibilities that our production should attain to that point this century, but that it may reach Mr. Hewitt's estimate of 17,000,000 tons is quite probable. We cannot add 80 per cent. to our railroad mileage as we did from 1880 to 1890, but it is possible that we may build 70,000 miles, as we did in that period, and we are almost certain not to build less than 50,000 miles. Even this latter figure would give us about 220,000 miles at the end of this century.

There is certainly no decline in the rate at which we have been increasing our wealth as compared with the previous decade, and as we gained nearly $8,000,000,000 in assessed valuation and about $20,000,000,000 in true valuation, it is quite certain that at least as much more will be added to our national wealth before 1900, with a reasonable probability of the increase being much more.

The United States is now the leading manufacturing country in the world. We have far outstripped all other nations in the magnitude of our industrial operations. It is almost incomprehensible that in ten years the increase in capital invested in manufactures should exceed the total invested only twenty years ago. The value of our manufactured products increased about 60 per cent.; add 60 per cent. to the output of 1890, and we would have $13,700,000,000 in 1900: but that is too much to expect. The same rate of growth in mining interest in this decade as in the last would make our mineral output in 1900 nearly $1,200,000,000, while a smaller percentage of gain, only equalling in volume the total increase in 1890 over 1880, would bring the figures to over $950,000,000. If our coal-miners add to the output of 1890 as many tons as they added to that of 1880, ignoring in this the percentage of growth, 217,000,000 tons will be the production of 1900. No other country in the world ever advanced in population and wealth as the United States is doing. The progress of the past shows no signs of halting. In fact, the development of our foreign and domestic trade and commerce and of our industrial interests is steadily broadening out.

Contrast our position and condition with Europe. With resources surpassing those of all Europe ; with wealth-creating possibilities in soil, minerals, timber, and climate unequalled by Europe, and practically without limit to their profitable utilization ; with a homogeneous population of 65,000,000 people unvexed by the arbitrary regulations of half a dozen different governments and free from the drain of standing armies,—the United States justly commands the wonder and admiration of the world. Great Britain is no longer the manufacturing center of the world, for we have taken the foremost position in that line. Its vast iron and steel business is yearly increasing in cost of production, while ours is decreasing. It cannot meet the world's growing demand for iron and steel, because it cannot increase its production to any great extent. It produces less pig-iron now than it did ten years ago. Much of its ore it imports from distant countries. Its cotton is all imported. It spends about $750,000,000 a year for foreign food-stuffs. On the continent every nation is burdened with debt, and none of them can ever hope to pay off its obligations. Measured by their natural resources and advantages for continued growth against their debts and the many disadvantages under which they labor, they are practically bankrupt. In all of them the cost of production and of living must steadily increase. In the United

States we have scarcely laid the foundation for our future greatness. In natural resources we are richer than all of Europe ; we are paying off our debts faster than they are due, we have barely scratched the ground in the development of our mineral wealth, and our agricultural growth can scarcely be limited.

This paper was not intended as a logical discussion of the future based on the results of the past, but was simply designed to bring together a few of the facts which enable us to understand something of the amazing progress of this country, and thus, seeing what we have done, speculate in a general way on what will be accomplished before the end of the nineteenth century. We have a country of boundless natural resources, the greater part of which is comparatively thinly-settled. There is unlimited room for expansion. New railroads can be built in many sections and find profitable business awaiting them ; new mineral districts as rich as the best now being developed invite capital and energy; irrigation is making fertile great areas of Western land that were before worthless ; in the Northwest and on the Pacific coast there is a marvelous advancement ; the South alone has sufficient area and natural advantages to support a larger population than that of the whole country at present, and the development of that section will furnish a profitable opening for the surplus money of the East ; the growth in our commercial relations with South America and the West Indies brings into action new forces that tend to the upbuilding of this country ; the completion of the Nicaragua canal will mark the beginning of the most active era in our commercial and industrial history and revolutionize the commerce of the world in our favor. History affords nothing with which to compare our marvelous advancement. And yet, amazing as has been the progress of the last ten years, the coming ten will show a still greater advance.

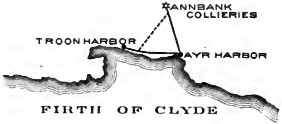
ENGLISH AND AMERICAN RAILWAYS.

A COMPARISON AND A CONTRAST.

By William M. Acworth.

FIRST PAPER.

WHEN the invitation to contribute these articles to THE ENGINEERING MAGAZINE reached me, I was stopping at a country house in Scotland, close beside a newly-constructed railway, and it occurred to me that I could hardly adopt a better method of drawing the attention of American readers to the enormous difference between our railways and theirs than by describing this little line—it is scarcely more than three miles in length—in some detail. The reason for the existence of the line, in itself instructive, will be clear to any one who will glance at the accompanying plan, on which it is indicated by a dotted line. Annbank collieries, which are close to the Firth of Clyde, have been accustomed to ship their coal at the harbor of Ayr. A few miles along the coast is a rival harbor at Troon, which naturally enough wanted a share in this trade. For this purpose it was evident that the railway rate to the two ports would need to be the same. But if the coal were sent by the existing railway through Ayr, and then along the coast to Troon, the same rate being charged for the whole twelve miles as for the first five only, it was likely that the Railway Commissioners would hold that an illegal preference was given to Troon. So the railway company was induced to construct a new direct line, avoiding the Ayr *détour*. This new line is single-track throughout; there is no station on it; no passenger trains are run over it. Half-way along it there is a siding at which coal and manure can be delivered to the adjacent farms, and milk, potatoes, and other produce received from them.



And this is how the line is constructed. At either end there is a signal-box, built to control the junctions with the old lines. The capital cost of these two boxes, which are only open during the day, we may reckon at about £250 apiece; and they cost about £100 each per annum for wages and general maintenance. Needless to say, all the switches and signals are interlocked, and equipped with facing-point-locks, rising-bars, and all the other elaborate machinery so dear to the soul of our English inspecting authority, the Board of Trade. The very manure-siding is furnished with derailing switch, facing-point-block, and ground-disk signal,—what Americans, I believe, call a "switch target," except that our ground-disk is lighted after dark,—and a tiny signal-cabin has been erected to contain the necessary levers. Yet further security is afforded by the fact that the line is worked on the staff-system,—in other words, no train may pass over the line, even though the signals are all right for it to proceed, unless the engine-driver is in possession of a staff, of special color and shape, which, being the only one in existence, assures him that no other train can be on the line at the same time. As for the road itself, in its entire length there is not a single grade-crossing. In their place there are fifteen over- and under-bridges, some built in solid masonry thoughout; others with steel girders laid on masonry abutments. The bridges are all constructed of sufficient width to allow of the doubling of the track hereafter if necessary. The right of way, some 70 feet wide, is fenced off on either side by a stout wire fence four feet high. The new steel rails, 90 pounds to the yard, are supported on chairs weighing 44 pounds each, fastened down to the ties—"sleepers" we call them—with four spikes apiece. There are eleven sleepers, 9′ 10″ by 5′ and creosoted, to each 30-foot rail; and they rest on two feet of broken-stone ballast. Heaps of furnace-ashes, lying here and there along the line, show that, when the stone ballast has had time to consolidate, it will have a top-dressing of cinders to make everything tidy. In fact the line is in all respects up to first-class main-line standard, and fit for the passage of passenger expresses at sixty miles an hour.

"What did it cost?" will be the natural question. In round figures, it may be said, £33,000, or £11,000 per mile. In other words, a line constructed to carry a minimum quantity of goods and mineral traffic—for the average at present is less than two trains each way per diem—through a flat agricultural district, has cost as much as an average mile of railway in the United States. If our cheapest possible line costs so much, no one who knows England, who has appreciated from personal observation the vast preponderance of main lines and of railways in thickly populated districts with two or even four tracks over mere single-track country branches, will be surprised that our railways taken all round have cost about four times as much per mile as those in America. But I may be asked where the whole of the £33,000 went to; and perhaps it is worth while to answer in a little more detail. Roughly speaking, the contractor, who finished the road up to formation level, got £18,000; the railway company supplied and laid the permanent-way itself, at a cost for labor and materials of about £7000; the balance of £8000 represents the price of the land,—about twenty-nine acres at a little under £300 per acre. The value of land in the vicinity of the line may be quoted at £80 an acre; and yet the company voluntarily agreed to pay at the rate of £300. How much of this excess represents fair compensation for damage done to the adjacent farms by the intersection of the fields; how much is really consideration to the landowners to induce them to refrain from opposing the construction of the line, is a question that neither I nor anybody else can answer. But the difference between £80 and £300 represents, I think, fairly enough the average difference between the price of land to an ordinary purchaser and to a railway company. Attempts have been made more than once to enable railway companies in condemnation proceedings to set off the benefits likely to accrue to a landowner from the construction of a line against the value of the property which is taken for the purpose, but it is now settled by law that such set-off cannot be pleaded.

The price of the permanent-way needs no special comment. As to the contractor's account, it is perhaps worth while stating that railway engineers estimate that a bridge carrying a public road over the line costs on the average about £800 for construction, *plus* £600 for the approaches. Reckoning interest and maintenance at 5 per cent. on this sum, such a bridge costs, therefore, £70 per annum. Now, a new railway cannot be built to cross a public road on the level without special parliamentary sanction, which is rarely given except under very extraordinary circumstances. Even then the company is compelled to maintain gates at the crossing, with interlocked signals, and with a gatekeeper in constant attendance. This expense cannot be estimated at less than £70 per annum. It is consequently as cheap for a company to build a bridge as to maintain a level-crossing.

I think I am right in laying stress on heavy cost of construction as the most prominent characteristic of English railways, more especially when compared with those of the United States. How far the engineers and the public respectively are responsible for this expenditure, a good deal of which is certainly without economic justification, is a question very much harder to answer. No doubt our engineers have been encouraged to be extravagant. Capital in England has been abundant these last fifty years. The great railway companies could raise £100,000,000 per annum for years to come without the slightest difficulty in placing their shares. Again, it is always pleasanter for a workman who takes pride in his work to finish everything off in the best possible manner, and not to spoil the look of it with makeshifts. Further, a line thoroughly substantially built at the outset is cheaper to maintain than a line on which money has been grudged to start with; and the engineer knows that, while the capital outlay is disposed of once for all, the maintenance charges will be brought up in judgment against him year after year.

All these considerations doubtless have had weight in making our engineers, if I may so express it, extravagant-minded; but I venture to believe that the influence of the whole of them put together has been almost nothing as compared with the influence exerted by outside pressure.

American railways have been constructed, almost at their own unfettered discretion, by engineers working for a public to whom railways were an absolute necessity, and who were ready to take with gratitude a railway of the most imperfect description rather than be left with no railway at all. American companies have found it difficult enough to raise even the minimum capital necessary to construct their lines. Had the public there been as exacting as ours, and had it been able to enforce its views through the action of a department of the Government like our Board of Trade, it would never have got any railways at all. To say that England could have done without railways altogether would of course be ridiculous, but at least they were not and are not for us so absolutely essential as they were and are in the United States. To-day many people think new railways to be wholly unnecessary in England, for, though for years past railway construction has been almost stationary, we have to-day three times as many miles of line per square mile of area as the United States has. Even at the beginning our people were not wholly dependent on the railways. We had an admirable system of roads throughout the length and breadth of the country; we had many thousands of miles of canals and navigable rivers; and further, no inhabitant of the United Kingdom was more than about sixty miles from the sea. Consequently railways would never have been suffered to exist at all in this country, had they been as reckless of human life and as careless of the inconvenience they inflicted on individuals, as American railways have been and to a great extent still are. An Englishman can only stare with astonishment, when he sees for the first time trains running through crowded streets of cities such as New York and Chicago. I have a vivid recollection of watching long trains of freight-cars running down the Tenth avenue in New York, to the New York Central's depot, in one of the busiest parts of the city. As I looked, I remembered that our most powerful company, the London and Northwestern, tried in vain for three years to obtain permission to move one truck at a time by horse-power across a narrow street in a very quiet parts of London, in order to connect together two different part of the company's own property.

Again, one reads week after week in American newspapers accounts of accidents in which passengers lose their lives. The American public seems to take it as a matter of course that such things must happen. In England, on the other hand, a serious accident excites a disturbance which does not die down for many weeks afterwards. In the year 1891, out of 900,000,000 passengers, precisely five lost their lives by accidents to trains of all sorts and kinds. In the autumn of last year there was, after an interval of two years, a serious accident,—that at Thirsk,—which resulted, I believe, in about a dozen deaths. Thereupon the following resolution was passed, not by a young ladies' debating-society, but by an assemblage of hard-headed men of business, the Wakefield Chamber of Commerce:

> In view of the large number of railway accidents that have in recent years occurred to passenger trains in consequence of goods-trains being run on passenger lines, the time has arrived when Parliament should compel all companies to provide a separate set of lines to be used exclusively for goods traffic on main lines, and under no consideration should goods-trains be allowed to cross or be shunted on any portion of the main passenger lines, and such lines should be used exclusively for passenger-train service.

Such being the state of public opinion, it is perfectly impossible for the railway companies to disregard it. No company could expect to obtain parliamentary sanction for the construction of a new line of anything but first-rate quality in all respects. Nor, when the line was built, could it obtain the sanction of the Board of Trade to the opening, unless the stations, the points and crossings, the signalling appliances, the engines and rolling-stock, all conformed to what I may call an ideal standard of safety. Yet again, if the line were not kept up to the same standard when opened, public opinion, taking one day the form of public rebukes from the Board of Trade, another day of questions and discussions in Parliament, or again of exemplary damages awarded to passengers injured in accidents, would soon compel the company to realize that lavish expenditure was after all the truest economy. But perhaps this point has been labored overmuch. I am anxious, however, that American readers should appreciate that the enormous cost of construction and working of English railways is due not to any single and remediable cause, but to a whole series of national tendencies and characteristics, acting over long periods of time and only to be changed very gradually, if at all.

Now let us turn to another point. The very large capital outlay of English railways is of course one main reason of the high standard of rates and fares in England. Exactly how high that standard is we have no means of knowing, for our railway statistics, made up in a form that was laid down by act of Parliament about thirty years back, carefully suppress the information that it is most necessary for us to have. Ton-miles and passenger-miles are not here recorded. We know that each ton of goods carried pays the railways on the average about 60 cents. If we guess that the average distance is about 25 miles, we arrive at an average rate of 2.40 cents per ton-mile, which is not very far from three times the average rate in the United States. So in the case of passengers we may guess that the average fare is about 1.75 cents per mile, which, though lower than the American average, is higher than in any European country. Such a result seems very far from satisisfactory. High cost of construction might have justified a high range of rates and fares at the outset, but year by year the traffic per mile of line open increases in density, and yet the goods rates hardly come down at all,—in the last year or two their tendency has been all the other way,—while the passenger fares only come down very slowly. And yet the explanation is not far to seek. Our services have always been expensive to work ; they are becoming more expensive year by year. In America train-loads are mainly limited by the capacity of the engines ; ours by the weight of goods or number of passengers that have had time to accumulate in the very short interval between one train and another. Let me illustrate : If a man is sailing from New York to Europe, he will choose his favorite line or his favorite boat, regardless of the time of day or the day of the week at which it starts. On the other hand, if the Manhattan Elevated were to try to run its trains only once in ten minutes in the slack hours of the day, the street-cars would rob it of the bulk of its passengers. Now, in England our business is all between places which in America would be regarded as close together. We call Manchester "the north of England," yet Manchester is only 4¼ hours from London. Consequently there must be trains between the two points at all hours of the day, to suit the convenience of passengers wanting to go at any time. Consequently, too, each train runs with very much less than a train-load of passengers. Then these trains must be run at high speeds ; for, though a few minutes more or less are of little importance in a journey of hundreds of miles, a quarter of an hour out of four hours is a very considerable percentage. High speeds mean few stops ; and few stops mean additional trains to serve the second-class stations. Then high speeds and frequent expresses for passengers mean high speeds and short trains for goods,—that is, half-loaded engines ; for an engine loaded to its full capacity moves so slowly—occupies the line, that is, for so long a period—that it is impossible to find room for it.

But it would not be true to say that the goods are worked at high speed simply for the convenience of the railway management. On the contrary, the demand for speed in the case of merchandise traffic is fully abreast of that in the case of passengers. Broadly, it may be said that the English goods-service is based on the supposition that, between important towns at least, whatever is handed to the railway company at the forwarding station over night will be delivered to the consignee the first thing next morning. Now, a service such as this, in the nature of things, can never be a cheap one.

But our service is expensive in many ways beyond the cost of mere movement. Continental railways stop on the outskirts of the towns ; American railways have, it is true, their depots in the heart of them ; but the depot is almost as old as the town itself, and is built on land bought probably almost at agricultural value. In England alone do the railways come into the heart of ancient and populous towns, occupying for their stations not merely land bought at building value, but land which was actually covered with buildings that had to be bought and pulled down to make room for them. I may be told, and no doubt truly, that terminal accommodation is costly in the great American cities. But the terminal cost of grain, say from Chicago to New York, spreads out pretty thin per mile when there are a thousand miles over which to spread it. President Roberts stated at a recent annual meeting of the Pennsylvania Company that the average cost per ton-mile on the line between Jersey City and Philadelphia was 1 cent, as against 4 mills on the rest of the system, and even on the New Jersey division of the Pennsylvania railroad I should imagine that the average length of haul over which to spread the cost of the terminal accommodation and services is a good deal more than our average of some twenty-five miles.

It must be remembered further that the costliness of the land on which our goods-stations are built operates indirectly also to increase the cost of service. Most of the London goods-stations, for instance, are built in two stories, and the goods-wagons are raised or lowered from one to the other by hydraulic lifts. Further it must be remembered that, in the case of the bulk of our merchandise traffic, the rates include the cost of collection from the consignor's place of business at one end and delivery to the consignee's place of business at the other. In fact, it may fairly be said that in many respects our goods rates should be compared, not with American freight rates at all, but with the rates in that country for "express." Let me give an instance: Happening lately to look in the rate-book at a small town in Yorkshire, I found that the rate for fifth-class—our highest class—traffic to a station five miles off was quoted as 15s. 5d. per ton,—in other words, 3s. 1d. per ton per mile. This sounds very terrible, but turn it another way round, and say that for the sum of 9d. the railway company fetches a case of hats or a bale of silk weighing 1 cwt. to the station, loads it into a truck, carries it five miles, unloads it, and delivers it in a cart to destination,—imagine all this, and this is what fifth-class traffic really means,—and the wonder will rather be whether the railway company is not out of pocket by the transaction. To sum up in a phrase: the difference between English and American railway service is that the American companies sell transportation wholesale at wholesale prices; the English companies transact a retail business and charge retail prices.

But it is not only to different methods of construction and transportation that the difference between the cost of English and American service is due. There can be no doubt that the newer civilization of America disregards the interest of the individual for the benefit of the mass in a way that startles our more conservative minds. I have ventured already to point out that the American farmer, who is knocked down and killed at a grade-crossing by a passing train, suffers that his fellow-citizens may have cheap railway service. I have indicated too how tender our Parliament is of the rights of the landowner whose property is condemned. The same general principle, I think, applies to the different views taken in the two countries in reference to questions of so-called preferential rates given to one district and refused to another. I must not go into abstruse comparisons between laws there and here. I am of course aware of the existence of the long- and short-haul clause in the Interstate Commerce Act. I know, too, that not a few attempts have been made in America, by legislatures and by railway commissions, to use exceptionally low rates, forced upon the railways by competition, as a measuring-rod for the adjustment of local non-competitive rates. But for all that it is true on the whole to say that American railways have been more free than ours to base their rates purely on commercial considerations, to adopt the only sound economic basis of a tariff,—that of charging what the traffic will bear. It seems to me that they have been able to do this because the American public was wise enough to regard mainly the interest of the consumer,—that is, the country as a whole,—while our public have been weak enough to listen to the expostulations of the individual producer fearing the loss of "the advantage of his geographical position," and to forget that his loss would be the consumer's gain. If permitted to generalize yet more widely, one might point out as a very curious fact, that in the United States, the most pronounced Protectionist country in the world as against foreign nations, internal intercourse is less restrained than anywhere else, while England, which is immovably on the side of free trade with foreign nations, has failed to see that the same logic which refuses to protect the English farmer by a duty on American wheat should compel the State to stand aside and leave English railways free to carry American imports regardless of their origin, at such rates as they find for themselves most commercially profitable.

There can be no question that the tendency of the law of undue preference as interpreted by English courts has always been to heighten the average rate charged. It is true that the decision in any individual case always leaves to the railway the alternative of either levelling up or levelling down, but I know no instance in which the railway company has in fact adopted the latter alternative. Let it not be supposed, however, that the legal tribunals are out of harmony with public opinion. The action of the legislature has been consistently in the same direction. The passage of the Railway and Canal Traffic Act of 1888 was followed by the withdrawal of large numbers of special low rates which had till then existed. That act, among other things, provided for a codification of all the maximum powers of charge of all the companies in the kingdom. Since January 1, 1893, this codification has come into practical force. Symmetry and simplicity have unquestionably been attained thereby; but if the universal protests of traders' associations have any foundation in fact, the uniformity has been reached much more by raising exceptionally low charges than by reducing exceptionally high ones.

But I have pursued, perhaps, too far already questions which are rather commercial and economical than matters of practical railway working. In my next paper I shall hope to deal less with the abstract causes of the difference between the railways of the two countries, and more with the concrete examples of it.

FALLACIES AND FACTS AS TO IMMIGRATION.

By Colonel John B. Weber,

United States Commissioner of Immigration, Port of New York.

I HAD the pleasure recently of addressing an audience in Cooper Union, New York, upon the subject of Immigration, and the editor of THE ENGINEERING MAGAZINE was so favorably impressed with what I had to say that he has requested me to prepare a résumé of the address for publication in these pages. It gives me pleasure to comply, for I deem the subject one of first interest and importance to the wide circle of practical men of affairs who read a magazine of this character.

The migration of human beings from one country to another, although seeming to proceed so freely, must not be attributed to slight causes. Given the same conditions, or even approximately the same, the average man is content to live and die about where he was born. The desire to enjoy a larger degree and a fuller measure of political equality in years gone by stimulated many Europeans to seek new homes in the United States. But this is not now much of a factor, for, with the exception of Russia, the thrones of Europe are so hedged in by nineteenth-century limitations as to be comparatively powerless for oppression. The great lodestone which has attracted by far the greater number of immigrants to our shores is the superiority of the conditions which prevail here over those existing abroad. You may attribute immigration to the advertising of land companies, to the greed of steamship agents eager to sell tickets, or to a desire to evade military service, and you will embrace after all but a small portion of the great volume tending to our shores. But when John, who has established himself here, writes to his brother Jacob, who remains in the fatherland, to come, because of the better opportunities to be found, the information springs from one who has tried the conditions in both countries and is sent to one who is influenced by the statement, not because of its bright colors, but because of its source.

We have received immigrants, as a rule, from the laboring and agricultural classes of Europe. The inhabitants of cities do not emigrate in considerable numbers, with the exception of those who belong to the ranks of laborers. A majority of the arriving immigrants is still destined for the western agricultural States, although a considerable portion remains in the large cities, especially in the east, on account of the tendency of the rural population to flock to the cities, which is observable everywhere in Europe, as well as here. To me the reasons for this drift from the country are plain,—namely, the easier conditions of life in the cities, a better opportunity for acquiring wealth, the superior educational facilities, and the more numerous attractions. The greater the improvement in the conditions of workingmen in cities, however brought about, the greater will be the exodus from country to city, the greater the congestion, and the keener the competition in the higher grades of labor in cities. When this becomes so extensive as to raise farm wages correspondingly, through depletion of the rural population, the movement will be checked, and the flow will turn the other way.

I presume that no one will dispute the advantages to our country of immigration in the past. We owe to the hewers of wood and the drawers of water,—to the hard-fisted toilers from abroad,—the building of our railroads, the digging of our canals, the springing up of cities, the creation of new States, and some acknowledgment for their share in contending for the supremacy of the Union in the country's great crisis. Since the earlier days of the republic the manual labor involved in these industrial achievements has been hired by the native American, whose superior intelligence, ability to command, shrewdness, and ingenuity have easily made him the leader for foreigners to follow.

But the question now before the country is what about the present and the future of the immigration problem. Of late years there has been an increasing stream from southern Europe of a class more illiterate than the more northerly element which formerly filled the ranks of migration in this direction. It is contended that this vast aggregation of ignorance is detrimental to the welfare of the United States. If this is true, we should stop it. Whether it is detrimental or not, we should at least diagnose the case carefully before proceeding to heroic treatment, for immigration is a growth, not an explosion, and the volume is so strong and the momentum so great that the air-brakes cannot be suddenly applied without a shock that will disturb existing conditions throughout the land.

It is urged by some that the incoming of foreigners brings about an unhealthy competition in the labor market and reduces wages; but where is the evidence that this is generally so? The tendency of wages here for thirty years past has been steadily upward, with hardly a check. Others claim that the foreigners contribute an abnormal share of inmates to our poor-houses and prisons. This is probably true, but it is because the foreigner belongs to the poorer half of the community. The pathways leading to crime too often branch off from the avenues of necessity. Still others complain that the ignorant element does our voting, controls legislation, and in the cities administers public affairs generally. This, if true, should be charged to the naturalization practice and not to immigration. But all of the ignorant vote is not on one side of the political line, and to the extent that it is divided one side counterbalances the other. The failure to neutralize it more nearly is due in part, at least, to the indifference of native-born citizens to the performance of their political duties.

There are still others who say that our population is becoming too dense, and that immigration should be stopped before we are actually in need of elbow-room. It has been estimated, however, by accepted authorities that we can accommodate seven times our present numbers without equaling Europe in density of population. The single State of Texas could have taken the entire inflow of the past ten years, with advantage to her interests, and still have had room to spare. Europe, in truth, does not suffer so much from over-population as over-taxation to support royalty and immense standing armies and navies, making the burden so heavy as almost to obliterate the great middle class, which is the strength as it is the pride and glory of this land.

Let us now consider briefly the various plans for adding to the existing restriction of immigration, now revolving in the public mind, and point out their probable effects and seeming defects. Congress has the power to stop immigration altogether, or to prescribe an educational test or a money qualification, or to exclude nationalities,—as has been done in the case of the Chinese,—or to prescribe any other restrictions, wise or foolish. If there had been in force from February 1 to November 1, 1892, an educational test, —namely, the test of reading and writing,—there would have been shut out at the port of New York, of those above the age of sixteen years, 57,000 out of 275,000 arrivals. If we had had the money qualification from January 1 to November 1, 1892, for persons over twenty years,—say $100, which is the amount most commonly suggested,—we would have shut out 194,000 out of 202,000.

I am not now advocating either of these plans, but simply desire to show their effect, believing it always to be wise, before en-acting a law, to consider what will be the result. Take, for instance, the Scandinavians, who present the smallest percentage of illiterates. Out of 42,000 arrivals during the period mentioned they showed but 289 who could not read and write. In this respect they made a better showing than would the population of any State in our Union. But they averaged only about $23 per capita for the same period. Of the 30,000 Scandinavians over twenty years of age less than 1300 would have been admitted under the $100 money qualification. Had this policy been adopted a few years ago, where now would be our Minnesota, our Dakotas, and portions of other States where, while the preponderance of Scandinavians is not so marked, their numbers are yet important? The present governor of Minnesota, Knute Nelson, would most likely still be plodding along in Norway had the money qualification been in force when he landed at Castle Garden. He is a strong character of marked abilities, who, although a foreigner, fought under the nation's flag for the preservation of the Union and the protection of the interests of all, native and foreign. In every walk of life, in the sciences and arts, in commerce and finance, in literature and the professions, we find foreigners who have lifted high the standard of progress in this country. Can any one advance a good reason why these people should not have come in?

Another plan which has been proposed, and which to the superficial observer seems to be the panacea for all our immigration evils, is that of inspection abroad by American consuls. This plan, I contend, would be the weakest in good results, the strongest in disadvantages, the most expensive in its enforcement, and the most deceptive and barren in its yield. It is a most cumbersome and complicated machinery, whose chief result would be to furnish the very people we do not want, and keep back those who are desirable. Almost the same result could be obtained by passing a law saying that no one shall come in who is physically able to care for himself, and that only those shall come who have just left the cradle or are nearing the grave. I don't believe in cross-eyed politics or cross-eyed policies. I don't believe in squinting at cholera and striking at immigration. I don't believe in indirect means to carry out that which we have the power to do directly. I don't believe in chanting our praises for furnishing an asylum for the oppressed and laying for these people with a shotgun at the border. I don't believe in exercising a power that has not the moral force and conscience of the community behind it.

Consular certification must be made either in the consular districts where the emigrant lives, or at the seaport where he embarks. At neither place has the consul personal acquaintance with the subject. He must obtain his information from the local authorities over whom we have no jurisdiction, and who may be expected to facilitate the emigration of the bad and hinder that of the good. I may illustrate by mentioning that the Italians must all have passports before they can legally leave their country, and no one against whom a criminal conviction has been recorded is supposed to receive such a document. Yet I recall a number whom I returned,—one in particular who had served ten years in prison, but who had a clean bill of moral health in the shape of a passport.

The results of the cessation of immigration are too far-reaching to be disposed of here, but I desire to call attention to one or two features which are certain to develop. First, we have been for years feeling the lack of sufficient domestic help, and where the servant girl of the future will come from, if we close the gates to immigration, I don't know. It may be said that we can make exception in the case of women, but women will not come unless their brothers and fathers, husbands and lovers come too. Where are the American girls who are ready to go into the kitchen? Indeed, it is all that we can do to keep the foreign girls in the kitchen after Americanizing influences have caused them to discard the kerchief tied around their heads upon landing, and don the high hat with feathers and birds instead. Then who will do the rough work constantly necessary in the development of our but partially touched natural resources? Will it be those who are already here, and who have been elevated above that grade of work? Hardly, for that means retrogression, and I do not welcome the day when the toilers of this country are obliged to take a backward step either in compensation or in position. Remember, too, that the labor that these raw hands perform makes the demand for work requiring more skilful touch. Coal and ore must still be mined, forests leveled, and fields plowed, and hundreds of what may be called coarser vocations must be filled by men who do not wear silk hats and dress coats. There must be privates in the industrial army, as well as brigadiers.

The natural increase in population will not supply the waste of time and the decay of brawn and muscle. Large families are no longer the fashion in America. Take the figures of population in the last census, deduct the arriving immigrants for ten years past, and we would show but a small growth during that period.

"We don't believe in unrestricted immigration," say some who have given very little study to the subject. Nor do I. Such people talk as though there were now no restrictions. There are on our statute-books laws excluding the insane, idiots, persons suffering from dangerous diseases, paupers, persons likely to become paupers, convicts, polygamists, and contract-laborers. Under these laws the immigration commissioners of New York State, during the five years preceding the control of the business by the Federal authorities, barred and returned to Europe 1977 people. From the beginning of Federal control, namely, April 19, 1890, to November 1, 1892,—about two years and seven months,—3051 persons were barred and returned. Besides, there were returned under the year clause (which I will refer to later) from the time that the law became operative, April 1, 1891, to November 1, 1892, 937 persons. This certainly shows some restriction.

"But we are receiving the scum of Europe, and paupers and criminals are dumped in wholesale fashion upon our shores," is said by some who have skimmed the surface, or by those whose real desire is to exclude all immigrants because it just now seems to be popular, but who seemingly have not the courage to avow their desires. There has been a great improvement in the sifting process at the threshold of the country. The practice of the authorities here, which is founded not upon mandatory law, but upon regulations, has been to take care of those who fall into distress within twelve months of their landing at the expense of the immigration fund, instead of sending them to the city hospitals at the expense of our tax-payers. The year 1889 showed an average daily attendance of 266 such immigrants. By 1892 the daily average had declined to 81 and a fraction. As to the assertion that Great Britain is dumping her paupers and criminals upon our shores, there may be isolated cases of this kind, but that there is a wholesale organized movement I do not believe. The facts on record in this connection are mainly ancient history.

The plan that I would suggest is laid down in a report made by Dr. Kempster and myself, from which I have seen no reason to deviate, except to add a clause vesting in the president of the United States the power to suspend immigration temporarily in the case of threatened pestilence, and possibly an educational qualification. The report was written before the outbreak of the typhus and cholera last year, and before illiteracy statistics were kept at the Immigration Bureau. I would hold the sub-agents of steamship companies, many thousands of whom are scattered over Europe, responsible for the sale of a ticket to a prohibited person, reaching him not directly by our law, for that is impossible, but striking his pocket through the steamship agencies or companies in this country, compelling him to pay the return passage of a defective immigrant and levying a fine in each instance if necessary; in other words, imposing a penalty which in a single case would wipe out the commission received in a great many. The sub-agent in most cases knows the applicant personally, lives in the same village with him, is familiar with his family history, and knows his conduct and his mental and physical defects better than any one who comes in contact with him after he leaves his home.

I would continue a rigid inspection here, and besides hold every alien immigrant after landing subject to compulsory deportation at the discretion of our courts whenever he developed into pauperism or criminality, and until he had assumed the burdens and acquired the privileges of citizenship. He would be regarded, in fact, as passing through the Immigration Bureau until he became a citizen. Every country in Europe except Great Britain deports alien paupers and criminals to their homes, and there is no sentiment or good reason which we would violate by adopting the same plan. We are now authorized to return to Europe within twelve months after landing a person who has arrived in violation of the immigration laws, or who becomes a public charge from causes existing prior to landing, and under this authority we returned more than 500 persons last year who could not have been detected by any process of inspection here or abroad, nearly all of whom would have become a permanent burden upon the public. Wipe out this year limit, extend it to cover the period of citizenship, and eliminate the requirement that we must show that the cause existed prior to landing so as to take in one who becomes a pauper or a criminal here, and we solve the problem of how to get rid of the undesirable element coming to us from abroad. Then guard better the avenues of citizenship, and a great many of the immigration evils will disappear.

In the enforcement of the contract-labor law it is exceedingly difficult to reach every case. The original intent of the law has been realized,—namely, the stopping of the wholesale importation of gangs of contract laborers. Individual violations of the law will occur doubtless as long as cases of smuggling and evasions of the customs laws occur. A practical remedy for these isolated cases is not easy to provide, but I believe that much could be gained if it were made easier to inflict the penalty upon the contracting party living here, instead of having that punishment fall as now upon practically innocent men, ignorant of our laws, who are returned because of their unintentional violation of them.

There is one other side to the immigration question upon which I desire to touch, and that is charged as being the sentimental side. I believe in sentiment in a government as well as in the home. Sentiment is part of the power that moves the world. We are all immigrants, differing only in the sailing dates of our ancestors. A few came over with the *Mayflower*, but the great mass of them came within the past fifty years, during which time the progress of the nation has been so rapid and so vast that it staggers arithmetic to compute and impoverishes language to describe it. And because I believe the marvelous achievement of which we boast to be so largely due to the incoming of immigrants drawn from the bone and sinew of all Europe,—for by reason of this we come in contact with new ideas, adopting the best and rejecting the worst,—I am not in favor of shutting off the vigorous, health-giving current because there may be a small rivulet of impurities trickling into it. Stop the impurity abroad and here as far as possible, and turn back the rest upon discovery after landing. I am not in favor of any plan which reaches beyond the exclusion of the physically and mentally weak, the vicious, the diseased, the dangerously ignorant, or those whose labor is contracted for on the other side to the detriment of the better-paid and higher-grade labor of this country.

At the entrance of our harbor, on a great granite pedestal, stands a statue, a figure of our national goddess, christened "Liberty Enlightening the World." Borne aloft in outstretched hand, burns a torch, which up to this time has cast no ray but that of welcome. Wherever the spark of liberty has kindled hope in human breast, wherever hope has crystallized into effort, that torch has been the beacon-light for persecuted humanity, the cloud by day and the pillar of fire by night. If it means this no longer, let us correct its reading as speedily as possible. Change the character of that symbolic figure; tear from its forehead its beautiful crown; let it be considered a grim sentinel forbidding approach; and let the light which dances over the waters of our beautiful bay mark a dead-line across which an alien immigrant will pass only at his peril.

THE DEARNESS OF "CHEAP" LABOR.

FROM AN ENGLISH POINT OF VIEW.

By David F. Schloss.

THE general increase in the remuneration of labor, which has taken place during the last three years throughout the length and breadth of the United Kingdom, has been witnessed by social reformers of every class with profound satisfaction. At the same time the fact that British trade, upon the prosperity of which the welfare of all sections of the community alike depends, is at the present moment severely harassed by foreign competition, is undeniable; and since many of our rivals have at their command labor remunerated upon a much lower scale than that prevalent in this country, it is not surprising that it should be asked: What chance can we hope to possess of holding our own in the contest for commercial supremacy if we go on steadily augmenting our wages-bill, while our competitors enjoy the advantage of cheap labor? To this question, however, it is proper to oppose another: Is it an advantage to a nation that its workers are ill paid? in other words, is low-paid labor really cheap?

The fallacy of the supposition that high wages necessarily involve a high labor-cost was pointed out more than a century ago by Adam Smith, who declared that "the wages of labor are the encouragement of industry, which, like every other human quality, improves in proportion to the encouragement it receives." Later on Senior showed that, although the French manufacturers paid much lower wages than the English, yet the cost of production was decidedly higher in France than in England. Still more copious proofs of the dearness of cheap labor were adduced by Lord Brassey, whose father, in carrying on extensive works in all parts of the world, had employed in turn many different kinds of labor remunerated upon very various scales, from the highest to the lowest. But Lord Brassey's "Work and Wages" was published twenty years ago; and since, in a question of so much importance as this, fresh facts are especially valuable, it may not be amiss to apply to its consideration the test of more recent experience.

Beginning with those industries in which the labor employed is of the coarsest kind, muscular exertion unaided by machinery being the main factor in production, the fact that in coal-mining high earnings, as a rule, go hand in hand with low cost of production appears very plainly from a table given in a valuable work lately published by the distinguished American expert, Mr. J. Schoenhof* :

STATE.	Yearly Earnings.		Wages per Ton.	
	1880.	1890.	1880.	1890.
Tennessee..........	$332	$392	.68	.82
Kentucky...........	261	334	.73	.70
West Virginia.......	295	391	.72	.60
Ohio	320	352	.86	.69
Illinois.............	382	357	.99	.69

If, again, availing ourselves of figures placed before the Labor Commission by Mr. J. S. Jeans, Secretary of the British Iron Trade Association, we compare the conditions under which coal is mined in the United States and in Belgium respectively, we shall find that, although the average annual earnings of all persons employed are in America more than double those received in Belgium, yet the labor-cost of each ton raised is lower in the American than in the Belgian mines.

Proceeding to examine the facts in relation to the manufacture of pig-iron, we learn from a book on "The Principles of the Manufacture of Iron and Steel," written by the great ironmaster, Sir Lowthian Bell, that the expenditure in wages incurred in producing one ton of pig-iron is seldom smaller in Germany than in England, though the Cleveland ironmasters pay wages from 35 to 40 per cent. higher than the German employers.† Still stronger proof of the superior efficiency of well-paid labor is afforded by the figures, founded on the accounts of an American blast-furnace, which are given in Mr. Edward Atkinson's "Distribution of Products," and which prove that, as between the two periods, 1860–64 and 1875–79, the cost in wages for each ton smelted exhibited a decrease of 14 per cent., while the annual earnings of each man employed had increased 37.68 per cent., and his output had augmented at the rate of no less than 55.82 per cent. Turning back to the pages of Mr.

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* *The Economy of High Wages.* New York and London: Putnam. 1892.

† In 1878 (six years before the publication of Sir L. Bell's book) a German commission reported that the cost in wages of the daily output of a German blast-furnace was 145.77 marks, while the labor-cost of the same quantity of pig-iron in the Cleveland works was only 115.77 marks.

Schoenhof's book, we find that this very careful author, basing his statement on actual working accounts, informs us that the labor-cost of making a ton of pig-iron is less by 1s. 9½d. in Pittsburgh than at Middlesborough, and this though the English workman receives wages lower by about 40 per cent. than his American compeer. Nor is the superiority of "dear" labor less patent when we compare with each other the different parts of the American republic. For, in a recent report of the United States Commissioner of Labor it is stated that, while in the Southern States, where a man's earnings are upon a relatively low scale, ranging from 10.5 to 12.1 cents per hour, fourteen out of a total of twenty-one establishments show an output of less than .08 of a ton per man per hour, and of the remaining seven, five have an output of under .10, in the Northern districts, in which labor receives a higher remuneration out of fifty-five establishments, paying wages of from 11.1 cents to 18.7 cents per hour, no less than forty-three can show an output of .08 of a ton per man per hour or more, twenty-six of these producing at the rate of .10 of a ton per man per hour and upwards.

So far we have been dealing with industries in which the labor of the workman receives no assistance, or only a minimum of assistance, from machinery. In most forms of modern industry the abundant use of machinery, especially of machinery driven by motive power, plays an important part ; and in this connection it is of importance to remark that, while the judicious adoption of mechanical improvements constitutes a very potent means of keeping down the cost of production, nothing so strongly tends to promote the introduction of perfected machinery as the prevalence of high wages. It might, indeed, appear natural to suppose that the desire of manufacturers to increase their profits would, of itself, suffice to induce them to diminish the cost of production by introducing machinery wherever possible. But, as a matter of fact, so long as an employer can get his labor "cheap," he does not bother his head about labor-saving appliances. Thus, it was only after the Gas Light and Coke Company had been obliged to concede the demand made by their men for the introduction of an eight-hours working-day, and had thereby incurred an extra expenditure in wages of £70,000 a year, that these employers thought of adopting machinery for the purpose of drawing and charging their retorts ; nor, until their coal-porters insisted on having their wages raised very considerably, did the Company begin to make use of mechanical appliances, which now enable them to get the work done at a rate lower even than what it had cost them before this demand for increased wages was made. There can be no question that the high remuneration of labor affords a most valuable stimulus to the energy and the inventiveness of employers; while obsolete and wasteful methods of production will be observed to prevail where low wages are the rule.

In many English industries the pressure of our relatively high wage-scale has been sufficient to secure the adoption of methods of production greatly superior, at any rate, to those prevalent in the Continental workshops. Yet even in these industries the still higher rates of wages current in the United States have led to the introduction of appliances in a notable degree more perfect than those used in England. Thus, in the manufacture of rails, Mr. Schoenhof tells us that much of the work, which at Middlesborough and Darlington is done by simple manual labor, is in the United States performed by automatic appliances, the consequence being that the American employer is able to give his men two-thirds more pay than his English rival, and is nevertheless in a position to turn out his rails at an expense for labor less by over 17 per cent. than the labor-cost in this country. But it is when we come to those English industries in which wages are but little above starvation point that the stagnation prevalent wherever manufacturers enjoy "the advantage of cheap labor" is most plainly visible. Take, for example, the nail-making trade carried on in the Midlands, a trade the condition of which has long been a disgrace to the fair name of English industry. In 1713 (as we learn from Mr. W. A. S. Hewins's "English Trade and Finance") the nailers worked from 4 o'clock on Monday morning until late on Saturday night for 3s. a week. The evidence taken by the Sweating System Committee in 1889 showed that a man and his wife can only earn between them from 10s. to 17s. in a busy week, and average much less. Much of the work is done in wretched hovels, often under most insanitary conditions; and many of the women injure themselves in a grave manner by the use of the heavy "oliver," employed in cutting the cold iron. But in America, as Mr. Schoenhof proves, the manufacturers, availing themselves of the best methods and the most improved machinery, are able to turn out nails at one-half the labor-cost incurred in England, and that although the American workman receives wages fully ten times as high as those of the Dudley nail-makers.

The instance just cited may be taken as an extreme case of the pernicious effect of low wages in checking the legitimate economic evolution of a manufacturing industry. But, in truth, the conditions under which our nail trade is carried on, with its retention of wasteful and vicious methods of production, with its domestic workshops, with that irregularity of employment which is the invariable accompaniment of the domestic, as distinguished from the factory system, with its multiplication of little masters and of middlemen (" foggers ") buying the output of the scattered forges to sell it to the " manufacturer,"—all these conditions are present in each and every one of those numerous " sweated " industries, the evils prevalent in which have, ever since Mr. Burnett, the labor correspondent of the Board of Trade, made his famous report on the sweating system in 1887, received so large a share of public attention. The horrors of " the sweating system " in the clothing trades were so fully exposed before the Lords' Committee that it were needless to describe them here. But what it may be useful to point out with all possible distinctness is that the real reason why these horrors exist is simply that the employers in these sweated trades have, in the absence of that invaluable stimulus which the pressure of high wages can alone adequately supply, resolutely set their faces against the adoption of improved methods of manufacture. If the manufacturers, who ask us to believe that the retention of " the sweating system " is an economic necessity, would only muster up sufficient energy to erect proper factories provided with improved machinery run by steam-power, then, with suitable organization, they would find it perfectly feasible to sell their goods as cheap as ever, and yet to pay decent wages to their workpeople. This is no wild hypothesis: the thing is actually done. In the metropolis the wholesale clothing firms, having at their command a boundless supply of " cheap " labor, have (with very few exceptions) steadfastly declined to avail themselves of modern appliances, preferring to send their work out to be done in the slum work-rooms of East London under the worst possible industrial conditions. But in the provinces (at Leeds, for example) there are magnificent tailoring factories in which the pay and the conditions of labor are incomparably superior to those prevalent in the metropolis, and which nevertheless find themselves easily able to keep pace with the " sweating-dens " in the race for cheapness of production. What is true to-day of the tailoring trade was, until a short time back, no less true of the boot trade, as carried on in that pet paradise of the purchasers of cheap and nasty labor, the East end of London. Prior to the strike against "the sweating system" (in April, 1890), the London manufacturers used to send their boots out to be "finished" to "sweating-masters," who got the work done in noisome garrets and cellars by men working eighteen hours a day at a wage of about 3d. per hour. It was in vain to remind the London manufacturers that in the American factories, as had been conclusively established by Mr. Schoenhof's Consular Report of August, 1888, the very same processes were being performed by men in receipt of high wages, but assisted by the most efficient power-driven machinery, actually at a lower cost than in the Brick Lane "sweating-dens." So long as these employers were able to get their labor "cheap," so long did they stick to their obsolete methods of production. Now, entirely as a result of the pressure applied and maintained by the operatives, who have insisted that low cost of production shall no longer be secured by means of the oppression of the workers, the American machines have been freely introduced both in London and in the provinces, and no one to-day could venture to assert that "cheap" sweated labor is essential to enable English boot-manufacturers to compete successfully with their foreign rivals.

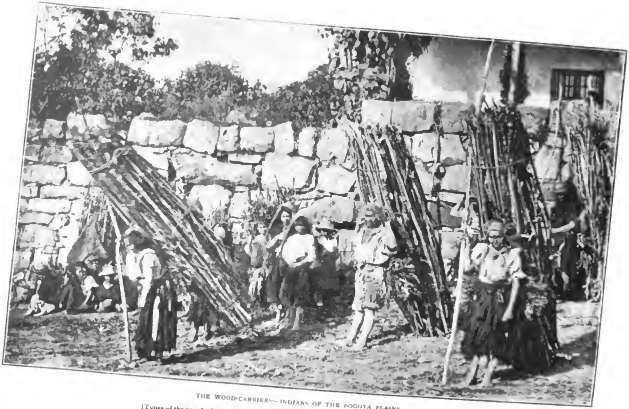
No better proof of the direct influence which high wages exercise upon the productivity of machinery could be given than that which is afforded by the history of our great textile trades. If we go back to the first years of the century, we shall find the gradual rise in wages accompanied by a steady increase in the efficiency of the operatives. Thus, while in 1804 an operative spinning fine cotton ("200's") turned out no more than nine pounds of yarn in a week of seventy-four to eighty hours, earning, after paying his assistants ("piecers"), a net wage of 36s. 6d., in 1833 the output of a man employed (on similar work) for only sixty-nine hours in the week was no less than nineteen pounds, and his net wage was 42s. 9d. It was shown before the Committee on Artisans and Machinery which sat in 1824 and 1825 that, while the earnings of English cotton-spinners were double those paid to French operatives, the Englishman got twice as much off a given number of spindles as the Frenchman. In 1836 Ure, in his work on "The Cotton Manufacture," said that the daily output of 800 spindles when spinning "40's" was sixty-six pounds in England, but only forty-eight in France. But the Lancashire of 1892 is even further in advance of the Lancashire of 1836 than the Lancashire of 1836 was ahead of the France of that date. For, if we compare the figures given by Ure with those contained in the excellent study of the cotton trade which has recently proceeded from the pen of that competent economist, Dr. von Schulze-Gaevernitz, we shall find that the work which in 1836 it took 508 of our operatives (spinners and piecers) to perform is now done by 97 only. To give an accurate idea of the superiority of the British cotton-spinner of to-day over his foreign compeers would scarcely be possible without entering too much into the technical details of the manufacture. But a few salient points may usefully be mentioned. While (as Dr. von Schulze-Gaevernitz states) in many of the German mills it takes five "hands" to tend one pair of self-actor mules with only 1300 spindles, and while even in some of the best German factories the same number of operatives is required to tend 2000 spindles, in Lancashire (although we run our machinery faster than the Germans) a pair of mules with 2000 spindles is worked by one spinner with only two assistants. Another matter well worthy of notice is the fact that, while in the smaller German mills there is one overlooker to 3000 or 4000 spindles, and in the best German factories one overlooker to 10,000—20,000 spindles, we in England require only one overlooker for from 60,000 to 80,000 spindles. Now let us turn to the comparison of the work of English and foreign operatives given by Dr. von Schulze-Gaevernitz (his figures relating to the manufacture of "36's twist"):

COUNTRY.	No. of spindles on each pair of mules.	No. of operatives to each pair of mules.		No. of hours worked per week.	No. of pounds of yarn spun by each pair of mules per week.	Labor-cost per lb. in pfennigs.	Wages of operatives per week in marks.	
		Spinner.	Assistants				Spinners.	Assistants.
Southern Germany.	1,472	1	3	65	1,095.5	4	21	7.70
Switzerland.......	1,200	1	2	65	850	3.9	18	7.50
Saxony.........	1 704	1	3	65	1,550	3.35	21	8-13
	2,000	1	3	64	1,800	3.2	22	9-13
Oldham.........	2,376	1	2	55	2,182	3.25	38	17.75
	2,688	1	3	55	2,723.6	2.88	40.15	12.9

If we contrast the first with the last of these rows of figures, and remark that, while the rate of pay (per hour) in the German mill is lower in the case of spinners by over 120, and in the case of their assistants by about 100 per cent. than that received by the Oldham operatives, the labor-cost is nearly 40 per cent. higher in Germany than in Lancashire, we shall not fail to see how great is the disadvantage to our foreign rivals of that "cheap" labor which is, in truth, so extravagantly dear. What is true of cotton-spinning is no less true of cotton-weaving. The well-fed English weaver can without difficulty look after four looms, and can with the aid of a juvenile assistant ("tenter") manage as many as six. But, as Dr. von Schulze-Gaevernitz tells us, notwithstanding that the Continental manufacturers run their looms from 20 to 30 per cent. slower than ours are worked, in Mulhouse and in Switzerland each weaver can only tend three. The effect of the superiority of the English operatives upon the cost of production is shown by the fact that, although the rate of remuneration of our English weavers is about 100 per cent. higher than that received by the Swiss and German "hands," yet we are able to turn out cotton cloth at a labor-cost distinctly lower than that in Switzerland and Germany.

It is, of course, impracticable within the limits of this paper to deal fully with the whole of the textile industries. But let us take just a glance at the facts in relation to the woolen trade. It is well known that the wages paid to the operatives in our woolen industry are, to a marked extent, lower than those received by the "hands" employed in our cotton mills. According to the evidence given before the Labor Commission by a Bradford woolen manufacturer, an adult spinner (at Bradford the spinning is done by women) earns from 7s. 6d. to 8s. 6d. a week, or if specially skilful from 10s. to 11s. 6d.; while women engaged in weaving are said, by one Bradford employer, to be able to earn 16s. 8d. in a good week, and, by another, to average 12s. 7¾d. a week throughout the year, a representative of the trade union assuring the Commission that their average earnings from year to year are only about 9s. a week. The warp-dressers in the woolen trade (mostly males) are shown to earn, if fully employed, 25s. to 28s. a week. Contrasting with these figures the earnings in the cotton trade we find that a first-rate cotton-weaver, whether female or male, can earn from 28s. to 30s. in a week, the earnings of a "hand" of average competence being 20s. a week, while the weekly earnings of cotton-spinners average 35s., and in some cases much exceed this amount. Now, the point of interest for us is that, while, on the one hand, this country is at the head of the world so far as the manufacture of cotton goods is concerned, and sends its cotton yarns and cloths into all parts of the globe, on the other hand, in respect to woolen goods, such as are made at Bradford, we are totally unable to face foreign competition in the outside markets, the trade being carried on upon a relatively minute scale for the home market only. It is true that the splendid specialties of the Huddersfield manufacturers go all over the world, and nowhere meet their superior. But, then, the wages paid at Huddersfield are much higher than those paid in the other woolen-manufacturing districts.

Enough has been said fully to justify the assertion that, whatever be the difficulties with which our manufacturers have to contend, the comparatively low rate of wages obtaining in other countries cannot with propriety be reckoned among the obstacles to the success of English enterprise. On the contrary, the higher remuneration which our work-people receive, accompanied, as the higher remuneration of labor invariably is, at once by the superior proficiency of the operatives and by the superior efficiency of the methods of production, creates for English, as compared with foreign industry, advantages of the most precious character. It is scarcely too much to say that the most serious danger which British trade has at this moment to encounter arises from the improvement which is taking place on all sides in the position of the workpeople in rival countries. In Germany wages are every day higher; and with the increase in its remuneration the productivity of German labor is by slow but steady steps concurrently advancing. Even the wide gulf which separates the English from the Indian cotton-spinner is being rapidly narrowed. Within the last few years the remuneration of the Indian operative has risen from 30 to 40 per cent., while his industrial efficiency has nearly doubled. Under these circumstances it must be clear that the true line of deliverance for our English industries, hard-pressed as these unquestionably are by foreign competition, is to be found in the augmentation rather than in the diminution of the wages of English labor. Of all conceivable ways of combatting foreign competition, the lowering of the English wage-standard would be the very worst. Among economic axioms there is none which deserves a greater measure of respect than the profound truth that "the laborer is worthy of his hire." The belief in the "cheapness" of ill-paid labor is the most dangerous of all delusions.—*The Fortnightly Review.*



THE WOOD-CARRIERS—INDIANS OF THE BOGOTA PLAINS.

[Types of the people through whose country it is proposed to construct the Pan-American railway.]

WOULD THE PAN-AMERICAN ROAD PAY?

By Charles P. Yeatman, M. Am. Soc. C. E.

IN view of the impetus given to the idea of building a railroad to connect North and South America, by the recent Pan-American Congress at Washington and the subsequent surveys by the International Railway Commission, I feel justified in saying something on a subject which has been treated more sentimentally than practically. It may not be out of place to add that the writer is a civil engineer of more than twenty years' experience, most of which has been in railroad surveys and construction, including nine years in South America, almost in the pathway of the proposed line.

In considering this enterprise from a practical standpoint the first problem is not "Can it be built?" but "Will it pay?" An inspection of the map of North and South America will make it appear doubtful that it will ever pay as a through freight and passenger route, for at its best it will compete for 1600 miles with a route which has been built since the creation, and has not had one cent spent on it for repairs. Over it a ton of freight from South America comes to-

DONKEY LOADED WITH EARTH.

[Now considered a satisfactory means of transportation by the natives.]

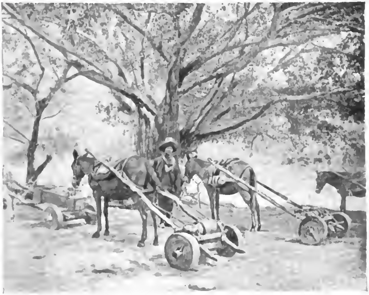
A PACK-TRAIN OF BULLOCKS, JUST UNLOADED.
[Transportation means now suited to native needs.]

day at the rate of less than a half-cent per mile or about half the average railroad rate. These may be called monopoly prices, for competition thus far has been out of the question.

A writer in *The Forum* for March, 1892, in treating of this subject, assumes that Carthagena, in the northwestern corner of South America, is the natural shipping port of that country, and compares the distances from it to various points in the United States by the ocean route and by rail via the proposed Pan-American road. In round numbers the distance from Carthagena to New York is 2100 geographical miles by ocean, and 4000 by land. The writer in *The Forum* claims, however, that the difference in distance by the two routes becomes less as we leave the Atlantic coast, making the point of equal distance at Kansas City, any point west of that showing a comparison in favor of the land route.

This comparison is made under the strange assumption that all the ocean traffic must pass through New York or Newport News. The fact is that much of it, to-day, goes to New Orleans, through the Caribbean sea and Gulf of Mexico; and by that path the ocean line to Kansas City, from Carthagena, is 2400 miles against 3100 via the Isthmus and Mexico. Hence, to reach Kansas City, the land line must compete in cheapness with ocean traffic for 1600 miles, and be handicapped by a loss in distance of 700 miles. On nearing San Francisco the distances become nearly equal, but the traffic would then be from the South Pacific port of Buenaventura, and the competition would be side by side with ocean traffic for 3500 miles; the land service competing with a line of steamers which carries passengers from San Francisco to New York, via Panama, for $125, or two cents per mile,—with one month's board and lodging included.

As the only part of the United States which would be as near to South America by rail as by a sea route is the Rocky-Mountain region, and as that is in no urgent need of rail connection with the tropics, we may say that as a means of saving distance the Pan-American railroad would be a failure. As a cheaper line for traffic it would hardly be a success. In saving time it might compete in the West for the carriage of passengers, mail, and express.



MODE OF HAULING HEAVY LOADS OVER THE ANDES.

[Pieces of the Bogota Mint en route.]

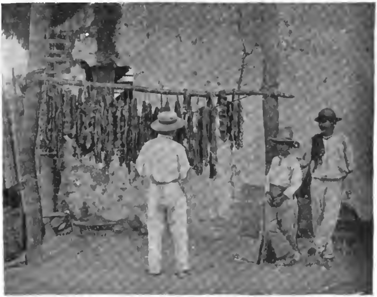
At present the trade of the United States with South America is made at the economical rate of ten miles per hour, but if necessary the speed could be increased to that of the transatlantic steamers, twenty-two-and one-half miles per hour, and at least 1600 miles of the railway would do well to average that rate of speed with its fastest trains. The most southerly point with which we have a rail connection is Jojutla, 183 miles south of the city of Mexico. From this point to Carthagena, via the Isthmus, the distance is 1600 miles, through a sparsely-settled country, with a few short pieces of railroad which run mostly east and west. Probably in that whole distance not fifty miles could be gained by using existing roads.

MAIN STREET OF PUERTO BERRIO, COLOMBIA.

At least 300 miles of the line, at the Isthmus, would be through a country which is entirely unsettled except where the Panama railroad crosses it, and where in one or two places on the coast there are a few fishermen's huts. In the mountain ranges in the interior are some tribes of savage Indians, but no civilized beings.

The reader who will study the illustrations accompanying this paper, all of which faithfully portray types of natives in the countries to be traversed by the proposed Pan-American route, and their occupations and means of support, will be more strongly convinced than he could be by words alone of the lack of local traffic which such a railway would experience.

To give an idea of the probable cost of a railroad through this country, we can take the Panama railroad as a fair example. Its 47½ miles of road cost $8,000,000,—or $179,000 per mile. At the same rate this 300 miles of road would cost $53,700,000. The question naturally arises: "How does the Panama railroad pay such high dividends?" and the answer is, simply by charging enormous rates. A first-class passenger who crosses the Isthmus pays $25 in United States gold for his ride of 47½ miles. The building of that road made but little difference in the amount of freight carried in vessels around Cape Horn. To day its main traffic is in its passenger, mail, and express service, and the carrying of the highest class of freight. This road was built by American capital and



NATIVE MEAT-MARKET AT GIRARDOT, COLOMBIA.

under American management, and the records of South American roads show that we can build roads there for less than half what the English spend on them.

The man who has not lived in a tropical swamp cannot properly appreciate that 300 miles of Isthmus. The water-supply in these swamps is ample for nine months of the year, but navigation in any direction is extremely slow and laborious. The water may vary from knee-deep to waist-deep until an abandoned creek channel, the current of which may be so sluggish as to be almost imperceptible, will suddenly show a depth of ten feet. The water is

A NEAT LITTLE HOME IN COLOMBIA.

THE HAY-MAKING INDUSTRY.

by far the least obstacle to a surveying party. Fallen trees, dense undergrowth, and vines, all plentifully supplied with thorns, make a mat through which scarcely a step can be taken without cutting a path. On a preliminary survey, dodging large trees, and avoiding all obstacles possible, a half-mile per day of line is good work. This requires four axemen at the front, equipped with "machetes," which are heavy knives from eighteen inches to two feet long.

There are species of palm which test these knives severely, and it will be an exceptional machete which escapes a thicket of these palms without at least one dent on its cutting-edge, and it is not uncommon to completely ruin a machete in five minutes' work. The foliage is so dense that it is rare that the engineer can see more than a hundred feet ahead. The sky is an unknown quantity, but mosquitoes, gnats, sweat-bees, ticks, chiggers, and carnivorous ants he has always with him.

The popular idea is that, since in this day of modern appliances and energy man can far outdo his ancestor of three or four centuries ago, he can overcome nature herself. Let us look at the

TYPICAL COLOMBIANS OF THE LOWER CLASSES.

[Laborers whose work is expected to furnish traffic for the Pan-American railway.]

history of this same strip of land. The Isthmus of Darien is but fifty miles wide. Balboa, in 1513, was the first civilized man to cross it. His men were loaded with armor and weapons, but they probably made natives cut a path for them through the tangled undergrowth. Of his 190 men but sixty-seven reached the divide; the rest were left behind sick or dead. The Spaniard returned, and later led 200 men who cut timber for four brigantines on the Atlantic shore, and carried the timber, with anchors, rigging, etc., over the mountains to a river which flowed to the Pacific. Here it was found that the timber, which had been cut near salt-water, was so worm eaten as to be worthless. A new supply was cut on the ground where they were, but a freshet carried it off and cut off their road to supplies until they were nearly starved. A third bill of timber was gotten out, and they finally reached the Pacific after losing many men.

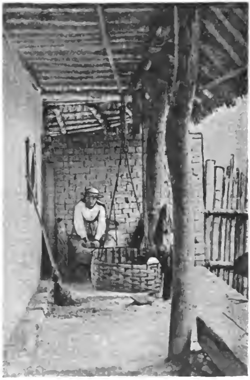
In 1849 there arose a demand for a ship-canal across the Isthmus. An Irishman named Cullen saw his opportunity for notoriety and cash, and published a book,—which had a ready sale for several editions,—in which he professed to have walked across the Isthmus of Darien several times, blazing trees to mark the way. He claimed that only three or four miles of deep cutting would be necessary to allow ships to sail from ocean to ocean. Cullen's story was so plausible that an English company sent a civil engineer, named

NATIVE METHOD OF CARRYING WATER

AN ILLUSTRATION OF THE ABSENCE OF ROADS AND THE DIFFICULTIES OF TRAVEL IN THE COUNTRY INTENDED TO BE TRAVERSED BY THE PAN-AMERICAN RAILWAY.

Gisborne, to make a survey and report. The Englishman, not to be outdone by any Irish bog-trotter, professed to have made the survey, and published a book giving details, with map and profile. He located the summit of the divide at 150 feet above sea-level.

This official report caused four nations to send expeditions to explore this part of the Isthmus and examine the route. An English expedition started from the Pacific, and after cutting their way through twenty-six miles of dense swamp undergrowth, then gave up the attempt. An expedition composed of French and English left the Atlantic side, guided by both Gisborne and Cullen. The former could not find his own stakes, and the latter could find none of his blazed trees, for the very good reason that they existed only on paper. The ground did not correspond to the map, and they were lost so completely in the Caledonian valley that they finally returned to their ship after having gone six miles toward the interior. The Colombian party, exploring their own country, made as complete a failure as the other two.



NATIVE MODE OF GRINDING.

[With cradle in the foreground.]

To our fellow-countrymen alone belongs the credit of having crossed from ocean to ocean. The United States expedition, with twenty-seven men, under Lieutenant Strain, of the Navy, left the Atlantic coast with

VIEW ON THE ANTIOQUIA RAILWAY, SHOWING DENSE TROPICAL FOLIAGE.

ten days' provisions, relying on Gisborne's map. They soon found that the map was not to be relied upon, but persevered in spite of terrible hardships. The divide was found to be more than 1500 feet high, instead of 150. Before reaching it they passed a small Indian settlement, but on the Pacific slope they found no sign of human habitation until they were nearly at the Gulf of Darien. The party would all have perished but for the energy of Strain, who, when he found the majority of them almost unable to travel, went ahead with two of the strongest men, reached the Pacific, led a rescuing party of English sailors and natives, and overtook his starving men scattered along the road over which they had come, trying to return to the Atlantic. They were covered with ulcers and boils, and were little more than skeletons. Strain was reduced in weight from one hundred and forty-five to seventy-five pounds.

But it is not necessary to go back forty years to get an idea of the trials awaiting the company, or nation, which attempts to disturb nature in this tropical wilderness. The last ten years have seen perhaps the most colossal and utter failure that the history of the world has recorded against the enterprise of mankind. The Panama canal was started ten years ago with the name of Count De Lesseps, the "Grand Frenchman," as his countrymen called him, at the head of the enterprise. He had built the Suez canal, and those who knew nothing of the Isthmus seemed sure he could build a canal anywhere. At an International Congress held in Paris his name and influence won a majority of the votes cast, in favor of his scheme to construct the canal at Panama in preference to at least six other proposed routes. He had no survey on which to base his estimates, and only a map and profile of the Panama railroad to give him any knowledge of the country. He insisted on a sea-level canal, without locks, and was ignorant of the fact that the tide on the Atlantic side is from twelve to eighteen inches, while that on the Pacific is from nineteen to twenty-one feet. He proposed to turn the Chagres river into the canal, and cited his Suez experience. He was not aware, though, that, while the yearly rainfall at Suez is 1.3 inches, that at Panama

NATIVE GOLD-MINING IN A REGION THROUGH WHICH IT IS PROPOSED TO RUN THE PAN-AMERICAN ROAD.

A NATIVE MARKET IN SOUTH AMERICA.

is 124 inches. In 1890 the rainfall at the Isthmus was 297 inches. In the month of July alone the fall was 52½ inches, or 11½ inches more than the annual rain and melted snow combined in Cincinnati.

NATIVE BOY CHURNING.

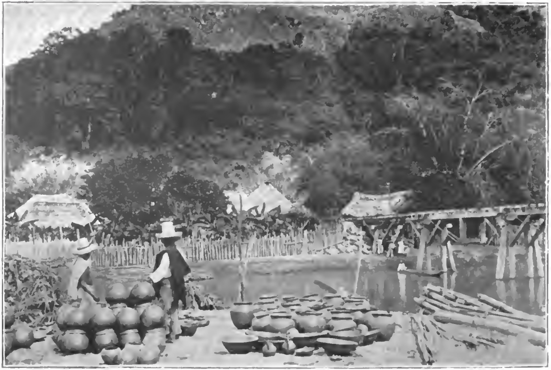
The representatives from the United States had a survey and detailed estimate of the Nicaragua route, with map and profile, showing a faithful study of the country, but the public sentiment was in favor of Lesseps.

The result was a Panama-canal "boom." Men and money were crowded to the Isthmus with not even a preliminary line run. Soon it was found that it would not be safe to turn the Chagres torrent with its irrepressible cargo of mud and drift into a level canal, and an estimate was made to cut a separate channel for this stream to the Atlantic. The estimate for this was nearly equal to the entire original estimate for the canal. In eight years the money was all gone, and it is difficult to say just how much the sum total was, but it was not less than $240,000,000.

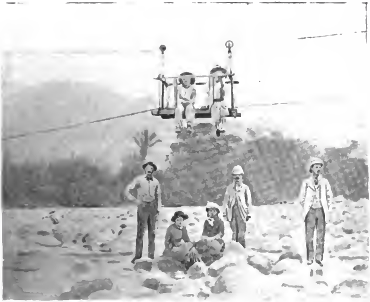
To day, if the attempt were to be renewed to build a sea-level canal at that point, it is said that less than one-tenth of the work necessary would be found done. Many of the deepest cuts have been almost filled by land-slides. Locomotives, cars, and costly machinery, representing millions of dollars, stand to-day on the Canal company's sidings, eaten by rust, and covered by tropical vines and undergrowth, a monument to the folly of the belief that nature is bound to succumb to modern man and his appliances.

The maintenance of way of a swamp railroad in the tropics is no small item. The only accurate data which I have at hand gives an underestimate in the case of the first road mentioned, as fully half of the line was on high ground, was new, and needed comparatively little repair. The Antioquia railroad, in 1883, cost for repairs of track and bridges $2266 per mile. The Cauca railroad, in the same year, cost $3837 per mile. These two roads are in Colombia, and are sometimes mentioned either as future feeders

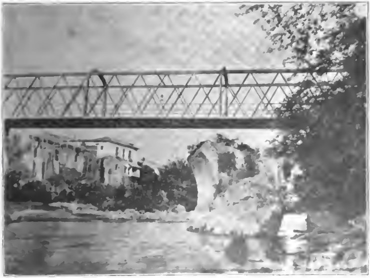
GOLD-MINING AT MALPASO.



THE POTTERY MARKET, HONDÁ, COLOMBIA.



CABLE BRIDGE ACROSS THE BOGOTA RIVER.



ANOTHER BRIDGE AT HONDÁ.

of the Pan-American railroad, or parts of its main line. On the Antioquia road, if the undergrowth were cut at the beginning of the rainy season, less than two months' rain was sufficient to form an arch of green trees thirty feet high, leaning over the track so as to shade it completely.

The constant change from dryness in the day to soaking moisture at night, even in the dry season, would soon ruin the best of timber, but nature furnishes a still quicker means of getting rid of it, in the shape of an ant or wood-louse, which is careful not to mar the outside of his domicile, but will patiently honeycomb the inside, until what looks like a solid twelve-by-twelve stick is but a shell from $\frac{1}{8}$ to $\frac{1}{4}$ inch thick, filled with dust and ants. The native timber suffered so much from the inroads of these pests that, upon

A SOUTH AMERICAN MINER.

hearing that yellow pine was used in Panama to avoid them, a trial of it was made on the Antioquia road. Georgia pine had to be shipped by way of New York, at a cost of nearly $100 per thousand feet, board measure, when put in place. When I left there, the first of my yellow pine trestles was being replaced. It had been built less than four years.

NATIVE COLOMBIAN WOMAN.

It is amusing to see with what confidence even civil engineers will write of a territory which they have never seen. An engineer in Peru wrote not long ago to the *Railroad Gazette* (New York): "Bogotá, the capital of Colombia, can be reached by a line up the valley of the Magdalena to Hondá, from which place a road is built to the capital. Average cost per mile would be quite moderate." I have been up and down that Magdalena river often, lived

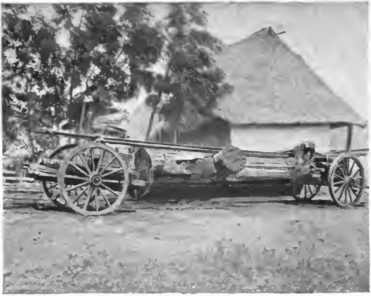
TROPICAL VEGETATION IN COLOMBIA LOWLANDS.

[Type of growth which can be kept in subjection only by constant vigilance, at great cost.]

BRIDGE OVER AQUAS CLARAS, HONDÁ.

on its banks for years, and made a survey for a railroad from a point above Hondá to Bogotá, and I can assure the writer that from the mouth of the Magdalena almost to Hondá—a distance of 600 miles—the valley is an abominable swamp, varying from twenty to one hundred miles in width, with oases of high ground few and scattered. The cost of railroad construction through it would be not less than $50,000 per mile for a very temporary road, and the traffic would not pay half the cost of repairs.

At Hondá there is a narrow gage road about sixteen miles long, connecting the navigation above and below the rapids, but not running in the direction of Bogotá. From Hondá to Bogotá there is a mule road, but it is not possible to drive a vehicle of any kind over it. On the plain of Bogotá there is a railroad twenty-two miles long, running from Bogotá toward Hondá, which has been built within a few years. My estimate of cost of a narrow-gage road from the Magdalena to Bogotá, ninety-six miles, was about $6,500,000, in Colombian money. This line had thirty-five miles



TRANSPORTATION OF A LOCOMOTIVE BOILER.

of 4 per cent. ascending grade, and curvature as high as 20 degrees.

In conclusion, I would say that in my opinion the Gordian knot of the Pan-American railroad problem lies in that crooked Isthmus of Panama and the country immediately south of it. At present it is certain that, if the road were built through the entire extent of the proposed line, no company or syndicate on earth would maintain it for the traffic which might pass over it. That tropical country is too sparsely settled, the people have too little need for exertion, and the governments are too unstable, to justify the risk of capital in any such venture. Reference may again be made to the pictorial arguments accompanying this paper, which can hardly fail to convince any but enthusiasts how unpromising is the field and the people for the building of an expensive railway.

REFRIGERATION FROM CENTRAL STATIONS.

By John E. Starr, M. E.

THE time and talent of the modern engineer have been largely occupied with efforts to simplify and cheapen operations involved in securing the primary necessities of domestic and business economy,—water, light, heat, power, transportation, communication, and the preservation of food. Capital and business acumen have gone hand in hand with the engineer, and so rapid has been the progress made, and so well has the public been educated in the advantages of the resulting improvements, that the luxuries of yesterday have become the necessities of to-day.

The "central plant," with its distributing arms reaching to the smallest consumer, has become a fixture in metropolitan life as permanent as the maintenance of pavements and sewers. The record of the development of methods for the distribution of water and illuminating gas is now deemed ancient history in engineering annals, and our attention is claimed for the progress of electrical distribution for light and power, the transmission of speech, the installation of compressed-air plants, and the attempts to distribute hot water and steam for heating. A new chapter may now be added to the already voluminous record of "central-station" work: the history of the distribution of refrigeration by underground pipe-lines from a central plant. The term "distribution of refrigeration," by the way, may not be a scientifically appropriate expression. In all of the other operations referred to something is sent to the consumer, as water, heat, or power. The refrigerating process is one of collection rather than distribution. For, instead of sending to the consumer something (as light or water) that he desires to make use of, the refrigerating system takes away from him something that he desires some place to be deprived of,—namely, heat.

The pipe-line refrigerating system may be termed the complement of steam-heating. In the latter process a vapor—steam—is sent out from the central plant, and, by means of branches, conveyed to the heat-transferring surfaces,—*i. e.*, radiators; there it is condensed into a liquid—water—and in so condensing gives *out* heat; the water is then returned to the central plant, where it is again vaporized and again sent out to the consumer.

In the refrigerating process a *liquid* of low boiling-point (such as ammonia) is sent out, and, by means of mains and branches, conveyed to the heat-transferring surfaces,—that is, the "expansion coils." Here the liquid is released from pressure and, owing to its low boiling-point, is vaporized, so *taking up* heat; the resulting gas carries the heat in a latent form back to the central station, where the heat is "squeezed out" by pressure and transferred to the sewer through the medium of the cooling water used on the condensers. The gas is again reduced to a liquid and again sent out. It will thus be seen that the working fluid is merely a vehicle to convey heat from the central station to the consumer, in the case of steam-heating, and to convey heat from the customer to the central station in the case of refrigeration.

The older method of conveying heat from the inside to the outside of a refrigerator is necessarily clumsy and its expense uncertain. The cutting of ice in winter, its storage through the summer, its transfer piecemeal to the refrigerator, the large amount of room required to hold the ice needed to take up the heat rapidly enough and to transfer it to the outside in the resulting ice-water are all serious disadvantages.

Up to the introduction of the pipe-line system only those who required large amounts of heat to be transferred could afford the appliances necessary to effect such transfer without using ice as an intermediary. To such large consumers of cooling power the introduction of ice-machinery has been of incalculable value. In the brewing, meat-packing, dairy, and cold-storage warehouse industries, the refrigerating-machine saves annually millions of dollars, and renders possible operations on an enormous scale. To secure to the smaller consumer the benefits, and to the vendor the profits, of mechanical refrigeration was the problem of the pipe-line engineer. The general economical advantages required to be preserved may be stated as follows:

First, the realization of enormous economy by operating in such a way as to transfer the heat directly from the customer to the central station without using ice as an intermediary.

Second, the great economic advantages in distribution.

Third, the general advantage of producing power on a large instead of on a small scale.

Fourth, the commercial advantage of being able to offer to the smallest consumer of refrigeration all the benefits and economies of artificial refrigeration now obtained only by large consumers.

To explain more specifically the first of the above considerations, it may be said that all refrigerating-machines have two ratings, one known as its "refrigerating capacity" and the other as its "ice making capacity." The latter is usually placed at the outside at only 60 per cent. of the former. That is to say, if we have a refrigerating-machine that will produce as much cooling power as could be obtained from 100 tons of ice, this machine, if placed directly at work on the space to be cooled, would manufacture only sixty tons of ice. This may be more readily understood when it is remembered that in ice-making the water which is to be frozen has first to be cooled by the machine from a temperature of 80° or 90° F. to the freezing-point before the process of congelation begins. This loss, together with the absorption of heat in and around the ice-making tank, makes up the 40 per cent. difference, and this is why all refrigerating-machines are catalogued commercially with the two ratings mentioned.

In the pipe-line process the refrigerating-machine is put directly at work on the spaces to be cooled. Where a central plant has the equivalent of 100 tons of ice to deliver to its customers, the artificial-ice plant has, with the same machine and the same expenditure in coal and engineer's wages, but sixty tons to deliver. This leads to the second consideration. The sixty tons of artificial ice with the expense mentioned are only delivered at the factory door. The 100 tons of the station have been delivered to the customer.

The delivery of ice, even to large consumers, is one of the principal factors of cost, while to smaller consumers, say of from 50 to 500 pounds per day, the delivery is by far the greater portion of cost. The service of ice requires usually a team of horses, a wagon, and two men for delivery in a comparatively limited district, and the cost of delivery by this method usually ranges from fifty cents per ton for the larger consumers up to $2.50 per ton for the users of small pieces of from ten to 200 pounds per day. This large "operating cost" of delivery, which to the ice-dealer is an item of expense, becomes to the pipe-line company an item of profit. The upkeep, or repair account, is little if any more by the pipe-line method than by the horse-and wagon system of delivery.

The methods by which these economies are preserved have been worked out to a satisfactory commercial result in two cities of the United States. The experiment was tried on a commercial scale first in Denver, Colorado, and later in St. Louis, Missouri. In the former city the first street pipe-line was laid in the spring of 1889 and in the latter in 1890. In both cities the lines have been gradually extended until a considerable part of the business portions is now reached by the refrigerating-mains. The advantages and the economy of the system have stood the test of time, and similar plants are projected at other points, such as Kansas City, Dallas, Brooklyn, Atlantic City, and Cincinnati.

As before stated, the operation of the pipe-line depends on the use of a suitable working fluid, having a low boiling-point. The fluid used in the majority of refrigerating-machines at this day is anhydrous ammonia. This is the fluid used in pipe-line work. At a temperature of 80° F. it remains liquid under a pressure of about 150 pounds, while at a temperature of one atmosphere it boils at about 30° below zero. Any refrigerator whose temperature exceeds 30° below zero, then, will transfer heat into this *liquid* and boil it into a vapor, provided the pressure in the "boiler" is kept no higher than one atmosphere. As it usually is not required to hold a refrigerator, even for freezing purposes, below 20° F., a higher pressure in the "boiler" may be permitted. For example, the boiling-point of ammonia at twenty-eight pounds pressure above the atmosphere is only 15° above zero.

An elementary pipe-line system, then, would only require a pipe strong enough to safely hold liquid ammonia under a pressure of about 150 pounds to carry the liquid to the refrigerator, and a second line, capable of safely holding ammonia gas, under a pressure of from one to two-and-one-half atmospheres, to take the expanded gas back to the factory after it had been "boiled out" in the piping placed inside of the refrigerator.

Commercial adaptability requires a more complex system of piping. In Denver and St. Louis the method of laying the pipe-line is as follows: A trench is made in the street, from three to six feet deep, at the bottom of which a half-section of twelve-inch vitrified sewer-pipe is laid, bedded in concrete, with the concave side uppermost. The iron pipes conveying the ammonia are carefully joined together and laid on saddles resting in the vitrified-pipe channel. After a thorough test for leaks the upper half of the twelve-inch vitrified pipe is laid on and a cement joint made with the lower half-section. The ammonia-pipes are thus entirely inclosed in a water-tight and practically indestructible conduit of vitrified-clay, the object of which is twofold: it gives protection and long life to the iron pipes by keeping them away from moisture and contact with the earth, and makes possible the prompt detection and location of leaks. Man-holes are provided at street intersections, and at other suitable points, where cocks in the main lines are provided, to permit the shutting off of certain sections, and to control generally the operation of the mains.

The ammonia piping system, as far as the mains are concerned, consists of a "liquid line," conveying the liquid ammonia under pressure; a "vapor line" or "return main," carrying the expanded gas to the factory, and a "vacuum line," the object of which will appear presently. The size of these main lines is regulated by the distance to which the service is to be carried and by the maximum amount of duty expected. At intervals of about thirty or forty feet a service branch, generally of half-inch pipe, is brought out by a T from each of the main lines. These three service-pipes are run together, usually through an eight-inch conduit, to a stop-box at the sidewalk, where suitable stop-cocks are placed, as in water- and gas-service. The three branch lines are carried on inside of the building to the customer's refrigerator. A coil or grid of piping is placed in any convenient position (usually on the side walls) inside of the refrigerator. This is called the "expansion coil" and corresponds to the radiator in steam-heating. At one end the expansion coil is connected with the liquid branch, and at the other end it is joined to the vapor branch. A suitable valve regulates the flow of ammonia from the liquid branch into the expansion coil. The latter communicates freely with the vapor branch. A constant suction in the return or vapor line is kept up in the central station, keeping the pressure in the expansion coil down to from one to two atmospheres. The regulating-valve is slightly opened and a tiny stream of anhydrous ammonia flows into the expansion coil. There, being relieved from pressure, it boils or vaporizes at a very low temperature. The heat to produce this vaporization comes from the interior of the refrigerator. The gas resulting from this evaporation returns by way of the vapor branch and return main to the central station, carrying with it the heat it has absorbed from the interior of the refrigerator. At the central station the gas is reduced by pressure and cooling to a liquid, which is again sent out into the liquid main. The amount of liquid allowed to flow through the regulating-valve is governed by the size of the box, the temperature required, and the general character of the service. Sufficient expansion coil is provided in every case to boil out all the liquid admitted. The liquid, being held under pressure up to the wall of the refrigerator, cannot expand or produce any cooling effect, so that no cooling power is wasted in the mains or branches. The only place where heat is taken up or cold produced is in the refrigerator, where it is paid for.

An important disadvantage met with in steam-heating from a central plant—that of large loss by radiation from the mains—has no counterpart in the refrigerating system, as in the latter no power is lost on the way.

The vacuum line is a vital portion of the system, for without it continuous operation could not be secured, nor could necessary repairs be made. The branches from this line are connected at each box with the liquid and vapor branches. Normally they are shut off from these branches by suitable cocks. In case of necessary repairs in or about the piping connected with the refrigerator, or of extensions required of the service inside of the building, or of a removal of the refrigerator, the liquid and vapor branches are shut off from the main lines at the stop box, and the cocks into the vacuum line are opened. At the station a vacuum pump connected with the vacuum main is started, and all the gas contained in the section required to be cleared is pumped back to the station and saved. A ten- or fifteen-inch vacuum is usually produced in addition to pumping back the gas. The piping may then be safely opened without the slightest smell of ammonia resulting. The vacuum line is also cut into the main line at man holes and other points, so in case of a leak the injured section may be rapidly cleared of gas. This line may be used as a "by pass" line to bridge one or more blocks, in case of injury to any portion of the other main lines.

The pipe line has so far been laid with such great care, and the development of proper fittings and valves has so far progressed, that little if any difficulty has arisen from leaks. In fact, in only two cases has a leak on the main lines occurred,—once each in St. Louis and in Denver. With the aid of the vacuum line these leaks were promptly stopped with little difficulty and slight expense.

To operate the pipe line successfully it is necessary to have at the central station a suitable refrigerating-machine. There are now in the market two types, compression and absorption machines, the general characteristics of which are familiar to any reader on engineering topics. Almost any machine in the market could successfully operate a pipe-line system, but for one fact. In ice-making, or in cooling a definite amount of space, such as a cold-storage ware-house or brewery, the operation of the machine is at a constant rate; that is to say, when one pound of liquid is sent out, a pound of gas is at the same time received by the machine, and the rate of such sending out and reception is constant. The refrigerating load on the pipe-line, however, is irregular, and its variations may be compared to the shifting load of an electric-light plant. One of the difficulties apprehended when the pipe-line business was projected was the difficulty in handling with the present type of machines such a duty as is indicated. The changes in the load occur at unknown intervals, and the amount of change could not be predetermined. The absorption machine was, therefore, chosen, as it more readily admitted of adaptation to this particular duty. In this machine, as is well known, the ammonia is distilled out of its combination with water or aqua-ammonia, and, still under the pressure produced in the distilling process, it is run through surface condensers and compressed into liquid. This liquid, after having performed its refrigerating duty and in so doing expanding into a gas, is returned to the machine and received into the water out of which it was originally driven ; it is then again distilled. It is important that this process of distillation should be kept up at a regular rate.

The pipe-line, however, calls for an irregular use of the product of the machine. This is easily handled with an absorption machine by storing up ahead, in reservoirs, considerable quantities of anhydrous ammonia, so that, if the line calls for a rate of outflow of the ammonia faster than the rate of distillation, the call may be met So far, this duty could be performed by a compression machine. But it is in the irregular flow of the gas back from the refrigerators that the real difficulty exists. With the absorption machine it is simply necessary to interpose between the absorber and the still pump a reservoir of sufficient capacity to hold in reserve a suitable amount of strong aqua ammonia. Another reservoir is provided, holding a surplus amount of weak aqua ammonia. The gas, therefore, may come back either rapidly or slowly, and it is only necessary to use sufficient of the reserve quantity of the weak aqua ammonia in the absorber to receive the returning flow of gas. The resulting product of strong ammonia is stored in the other tank to be distilled at leisure. The combination of these two tanks and the anhydrous-ammonia reservoirs, therefore, makes a complete system to allow for "come" and "go." The refrigerating service may vary within wide limits from hour to hour, while the distilling process may go on at a constant rate and the pressures on the main lines be held constant. In fact, this storage system in cold weather or with a light load makes it possible to stop the process of distillation altogether for a considerable time, while the process of refrigeration is steadily kept up.

The pipe-line system is elastic and admits of a wide number of applications. The bulk of the work so far performed by it is to take care of the regular storage-box for hotels, restaurants, saloons, butchers, butter and commission houses, etc. The particular advantages to this class of consumers are the low and regular price, the maintenance of lower temperatures than can be procured by the use of ice, cleanliness, relief from all care in the management of temperatures, and the room saved. The latter item amounts to from 20 to 40 per cent. of the total cubic contents inclosed by the insulating walls.

The principal hotels and restaurants and down-town butcher-shops in St. Louis and Denver are using this system in their storage-boxes. But the applications of the system do not end here. In many hotels, cafés, and saloons ice is required for water-pitchers and to crack up for mixing beverages. In such cases a miniature brine-tank is provided, through which the expansion coils connecting with the pipe-line are run. Molds of suitable size are placed in the brine, and the operation of ice-making is carried on just as at the large ice-factory. Where small amounts of ice are needed for cracking up, a small insulated reservoir is provided and the expansion pipes are placed close to the sides. Water is then poured into the reservoir, and ice forms on the expansion coils and extends towards the center of the reservoir until a solid mass is frozen. This is chipped out as desired, and new water added from time to time.

Another important branch of the business is supplying cold water for large stores, factories, and offices. The installation for this service consists of a water-tight insulated tank, having at the bottom a coil through which the hydrant water is passed on its way to the taps. About a foot of water is poured in on top of this coil, and just underneath the surface of this water the expansion pipes are placed. A sheet of ice five or six inches thick is formed by the action of the expansion coil, thus keeping the water coils constantly surrounded with ice-water of low temperature. The city water so cooled may be then carried by insulated piping to taps in any portion of the building. The cooling of soda-water fountains is effected in the same way. The manufacture of ice-cream is also more easily accomplished by the aid of this system. Other branches of business are also supplied, as the manufacture of perfumes and chocolate confections.

Among the luxuries furnished by this system may be mentioned the cooling of living-rooms, which, in such a climate as that of St. Louis, proves a great luxury. The refrigerating company there started in with contracts to reduce the temperature of cafés and dining-rooms twenty degrees below the outside temperature. No difficulty was found in cheaply reducing the temperature even to a lower point than this, but sanitary considerations, and the comfort of the frequenters of such places, determined that a difference of from ten to fifteen degrees between the inside and the outside temperature was the most satisfactory. It is interesting to note that the same piping used for the ammonia cooling service in the summer is used for steam heating purposes in the winter. It happens that in neither Denver or St. Louis do the pipe lines reach any of the hospitals, though the benefit of their use in such institutions is apparent.

As in every other central-station enterprise, commercial success in this depends on the volume of business that can be reached with a reasonable investment. The financier must look further than the successful attempts of the engineer in performing his duties of working out the mechanical problem. In this connection it may be said that Americans are the greatest users of refrigeration in the world. The poorest of our citizens are customers of the iceman. The refusal of an employer to provide cold water in summer for the most humble of his workmen would result in a strike, while the lavish use of ice in all things connected with bodily refreshment is a matter of surprise to the European visiting our country.

The results in St. Louis and Denver have shown that the business may be successfully carried on with an annual return no greater than $7000 for each mile of mains. In the business districts of the larger cities the demand for refrigeration per mile would be much greater than this. A canvass of five miles of streets in the business portion of St. Louis, for example, showed a present consumption of ice amounting to $170,000 per annum, basing the cost of ice (delivered) at the low price of $4 per ton. A canvass of three miles in Kansas City shows a demand of $72,000. In the better residence portions of these cities the consumption of ice is estimated, at $5 per ton, at from $12,000 to $16,000 per mile. In the middle-class section the annual demand, at the same price for ice, is from $8000 to $12,000 per mile. It is safe to say that any American city of 20,000 inhabitants could readily support the pipe-line system.

CONDITIONS OF FORESTRY AS A BUSINESS.

By W. J. Beal, M.S., Ph.D.

FORESTRY is a business, like agriculture,—an industry which is concerned in the production of a soil crop. It is the art of managing a wood crop so that it will make the best harvest of timber, in the shortest time, at the greatest profit. Forestry differs from agriculture, however, in that it takes many years for the crop to mature, and the crop is then a complicated one. Forestry in the United States as a defined business is now in its earliest stages,—chaotic or undeveloped. In its most perfect condition forestry is not a single science or art, but combines relations to several sciences and arts. On its scientific side it touches botany, chemistry, geology, meteorology, physics, geography, and entomology ; on the art side it touches horticulture, arboriculture, lumbering, and protection from fires.

In parts of Europe the growth of timber is already well systematized, but knowledge of the subject in all its details has been of slow growth. More than a hundred years ago a few alarmists in Europe prophesied an approaching dearth of timber. This agitation helped to induce economy in the use of timber and to delay the evils predicted. Without giving the strictest attention to systematic arrangement, we may note some of the chief attainments by the leading countries of Europe in the management of forests and the methods adopted to accomplish such results.

It would seem that government ownership and control of much of the forests in the old country gave a great advantage over our newer country, where "private enterprise" accomplishes almost everything. There, even the woodlands of corporations and of individuals are subject to the laws of the country, which specify how much may be cut in each year. These laws are enforced by officials well educated for the business. Forests are systematically inspected and reports made concerning their condition and needs. The inspector acts as "a paternal adviser" to all owners of forests. In the words of a recent American consul to Austria-Hungary : "The owner of forest land in Austria must exercise extraordinary care not to be guilty of trespass upon his own lands." How different the feeling of owners of land in the United States ! In the country above referred to the array of forest officials of various grades maintained numbers nearly 32,000 persons. In all of these particulars the fact must not be lost sight of that wages are much lower, and interest on investments much less remunerative, than in the United States.

The large number of officials who must pass rigid examination makes it possible and even necessary to maintain numerous schools to keep up a supply of skilled men. The encouragement of profitable employment induces pupils to patronize the schools, which give laboratory or practical work, often in the forests, as well as lectures in the class-room. To some extent these subjects are taught in other schools than those for the special object of educating foresters. These officials usually serve for life and are pensioned in old age or in case of disability.

By dint of great energy of a few persons in this country, attention has been called to the greed and dishonesty of men who steal timber from the public lands and to the evil effects of removing vegetation from mountain slopes. Many instances of the same kind have been enumerated in Europe, where the evil effects remain as a warning to newer countries. The cost of reclaiming some of these waste places has been great. In this reclamation seeds from the scattering trees cannot be relied on to furnish seedlings for the new growth, but nursery-grown stock must be well set and afterward properly cared for. Experience has led to the formation of many rules in relation to forest management. For example, on sandy soil and on steep mountain slopes timber can only be cut in narrow strips or thinned out. Grazing among timber is never permitted. Stringent rules in regard to igniting fires in or near forests are enforced.

Between 1860 and 1887 France reforested over 250,000 acres of mountain lands at a cost of $30,000,000, the State paying one-half. In 1887 the total annual appropriation for the forestry department of France was $5,000,000. Here the people of the United States may well take warning. How much more economical it would be to spend a little money now in preventing devastation than to suffer the consequences for a time and then possibly spend enormous sums in restoring the forests to the mountain slopes.

In Germany about 25 per cent. of the entire area is devoted to forests. Of this amount about 32 per cent. is government land; 15 per cent. belongs to communities; 1.3 per cent. belongs to charitable and other institutions; 2 per cent. belongs to corporations;

and 48 per cent. belongs to private parties. Without the supervision of State officials "a reckless devastation of forests would be the consequence,"—just the condition we are experiencing in most regions of our own free country. In the Eiffel district the mountain slopes were reforested and otherwise improved at the expense of the government, though much of the land belonged to communities.

A chief director of forests in Germany in writing to a United States consul says: "You are certainly quite right when you speak of the importance of forest culture for the United States, but allow me to express my belief that no earnest work in that direction will be accomplished there. The culture of the forests proceeds too slowly to suit your countrymen, and the profits are not forthcoming soon enough. In my opinion good results from forest culture can only be had in the United States when the government shall have taken the matter into its own hands." Dr. Otto von Hagen says: "The forest is a trust handed down to us from past ages, whose value consists not alone in the income derived from wood, but also in the importance which it exerts, through its influence on climate and rainfall, or land culture. Its importance is not merely a question of the present day or of the present ownership, but is also a matter which concerns the future welfare of the people." For these and other reasons it has been determined that it is a duty to interfere by legislation with the waste of timber.

Think of the time required to grow trees of certain species fit to cut for important purposes. In Germany the age for cutting oaks is 150 to 180 years; beech, 100 to 120 years; Scotch fir or birch 30 to 100 years, though for some purposes, of course, trees are cut when much younger. One of our consuls to France in 1887 observed that "forests are much more easily destroyed than replaced, for in three years, from 1788 to 1791, almost as large an area in France was deforested as has been reforested in the last ninety years, although much attention has been paid to the subject during this time."

The older and more thickly-settled countries of Europe have all passed through the stage in which many of our States have but recently passed or are now passing. Their land in most instances was well covered with forests. They cut and fired and wasted as we are doing, and have long been aware of many of the evil effects of this practice. To what extent shall we learn and profit by their mistakes?

Under the circumstances what can the people of the United States accomplish? In what ways can we best secure a reform in forest management? Legislation, whether State or Federal, will accomplish little, until there are enough stalwart persons thoroughly interested to continue under adverse conditions to work for the success of a better management of lands in forests or lands which ought to be covered with forests. Something may be done by forest commissions, but too much is likely to be expected of them, and to save expense somebody will advocate their abolition, —and somebody sooner or later will succeed. The value of forestry commissions consists chiefly in giving advice and in educating the people.

Tree-planting on a large and expensive scale is not likely soon to be so skilfully conducted that satisfactory profits will be apparent. But notwithstanding, trees of every kind should be planted in many places, and the sooner the better for us all. Probably not one in a thousand now knows enough about the subject to proceed intelligently to take the best care of his forest or to reclothe the land with timber in the most economical manner. Those who try the experiment should be able to wait.

Over a hundred years ago some persons in Europe were foolish (?) enough to plant a few white pines from North America. In the language of our time they would be known as "cranks," and yet who shall dare place a sufficiently high estimate on the value of that simple experiment, for it has demonstrated that our white pine is one of the best of trees to grow for timber in that country. We need men in every county of every State who will have enthusiasm and foresight enough to plant a few trees in places where there may be a prospect for growth a long time without molestation. Before these experiments are completed there will be many anxiously waiting to profit by the results.

We live in a comparatively new country, where our fathers and grandfathers cut down and burned the finest of trees to make room for crops and pasture. We have been taught to destroy trees and not to save them,—much less to replant. The arguments for preserving the virgin forests of a new country are by no means all on one side, and no one should expect the trees to be preserved. In most cases the profits of holding are too small to pay for the investment.

Michigan once had about 150,000,000,000 feet (board measure) of standing pine, which was believed to be well-nigh inexhaustible.

Those now living find remaining only comparatively small tracts in the back counties. Even with what might be considered good management in a thinly inhabited country, where lumber was cheap, it was soon found next to impossible to preserve this timber, however much the owners might desire to do so. In many seasons the fires destroyed as much pine as the woodman's axe. Dead pines must be cut to save them, and the débris was almost sure to burn and the fire to spread to the standing trees. To some extent the same condition of things prevails with regard to the "hardwood" trees, though in most cases these are not so likely to be destroyed by fire. In a business way there are men now spending much time and money in defending their remaining pine lands from fire. But more system is needed, and the care should be more general than it ever has been.

The study of European methods and results in forestry by competent men is not enough, says one writer.* It is not even the most important thing for us. Nothing can be very useful to us which is not based upon careful study of the conditions peculiar to this country. We must have in time a system of American forestry if we are to avoid serious disasters to our national interests and civilization. The forestry of this country must be the product of growth, which has as yet scarcely begun. It will be developed by continued and widespread observation, and by constant comparison of the results of practice. It is necessary to remind ourselves that no useful system of forest management can be originated or created by legislative enactment. There must be special knowledge and national good sense regarding the needs of this country, behind forestry laws, or they will be useless and mischievous.

It is important to understand the value of great areas of growing trees on the surrounding cultivated land, and to know in what respect they check fierce winds, prevent rapid evaporation of moisture, or encourage late frosts in spring. But the possession of this knowledge is not likely to induce men to save trees or to plant trees for the benefit of persons owning farms in the surrounding townships or in other counties. Here is one of the best of reasons why the State and Nation should take an active part in the management of forests.

It is difficult to induce most persons to understand fully the results of a timber famine. They have heard more or less of this talk for years, but they believe the day is yet far distant when our people will suffer much inconvenience from lack of timber. They argue that, as timber becomes scarce and more expensive, less of it will be used. We shall burn coal for fuel, and use more iron and steel. Transportation will be cheaper, and timber can be transported for long distances. The use of the land to produce various grains, grasses, fruits, and vegetables will help to pay higher prices for timber.

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* *Garden and Forest*, Vol. 1, p. 26.

In the moister portions of our country, when the original forests were cleared away, seedlings and sprouts in immense quantities sprang up to contend for every foot of available space. In cutting away the valuable timber there are usually large numbers of "young things" up to six inches or more in diameter, which, if protected from fire and other destroyers, have already made a fair start toward renewing the forests. Too little care is usually observed in protecting this young growth, which is admitted to be of no value at the present time. Because there are no dollars in them now, the proprietor is likely to let them go to waste. In very few instances in moist climates would it be necessary to plant trees started in the nursery.

The writer has often been asked by bright young men of no resources except their active brains and hands: "What is there in this country to encourage a young man, who must earn his living as he goes along, to make a specialty of forestry? I like the subject, and if I saw a good living in the business I should run the risk and go ahead." I am free to say that, so far, work in this field seems to be done gratuitously.

A few persons in our agricultural colleges have done a little in this direction,—mainly to call the attention of students to the magnitude and importance of a study of forestry. Before any one of us thought much about trees, the courses of study in these colleges were replete to suffocation with subjects of seeming importance. Elective courses are expensive. The writer has twice given a course of lectures daily for twelve weeks to members of the senior class of the University of Michigan—or to those who elected forestry. A course of parasitic fungi runs parallel with that on forestry, and only one of the two can be elected. No doubt there have been similar reasons in the other schools to prevent giving more attention to forestry. But if we are interested and make the effort, we can all find some opportunities for this work.

Lectures at farmers' institutes now held in many States afford some opportunity. But here the indifference of the hearers tempts us to select other subjects. Vividly does the writer call to mind one occasion at an institute in a new county in which he spoke of the importance of preventing forest fires. The first one to lead in the discussion was a farmer living in the neighborhood, who won the applause of the audience when he said of these fires: "They are the best friends we have in clearing up the country."

The more students know about trees, the more they are likely to be interested in this subject. The things to be learned are the different species, their names, their anatomy and physiology, their rate of growth and geographical distribution, their special uses in the arts and in nature, how to raise trees from the seeds, how to plant and where to plant and why, and especially how to take proper care of them after setting. He who fully understands the structure and functions of roots will never be seen carting living trees with roots exposed to dry wind and sun for miles along the highway. Students may be set to investigating the effects of pasturing a wood lot by noting examples of those pastured and those left to themselves. They may estimate the amount and value of an acre of good, medium, or thin forest, and note the time required to produce it. The effect may be noted of trees as a shelter along the highway, or near dwellings, barns, and sheds. Other questions are: Why are certain trees found growing in swamps and others on dry land? Why are there no pines or cedars in some neighborhoods, and no beeches or maples in others?

Besides the means suggested for aiding the cause, there are others: If the programs were judiciously prepared and well carried out, the celebration of Arbor Day by school children would have a tendency to awaken an enthusiasm among the people, but usually the exercises consist mainly of quotations from literary authors,—scraps of poetry, history, and sentiment,—rather than any substantial information pertaining to the needs of forestry. The establishment of an arboretum, even a small one on some of the farms of enterprising people, and more especially at each agricultural college and experiment station, would help to educate and interest the people. We cannot soon expect to see an Arnold arboretum in every State, but the beneficent influence of that garden has already reached thousands of miles.

Associations for securing the protection of certain private natural scenery help to educate every one who sees the reserves. Botanic gardens containing shrubs and trees are likely to increase in numbers, each good one lending encouragement to others. So of herbaria, and especially of museums of plant products which should contain no end to interesting specimens of timber, not only those which were well grown, but likewise all manner of monstrosities. The writer a few years ago collected and placed in position a unique collection of this kind, and, considering the cost, it was more attractive than an ordinary museum of fossils, minerals, or stuffed animals. Who can tell the good results likely to occur to forestry from the establishment and maintenance of the Jesup collection in Central Park, New York?

Several books have appeared that are worthy of notice, but none of them can be compared with "The Silva of North America," by Prof. C. S. Sargent, the first four volumes of which have been published. In several States reports have been issued by Forestry Commissions or forestry associations, or special bulletins on the subject have been published by experiment stations. The United States government has, through Mr. Fernow, the efficient head of the Forestry Division of the Department of Agriculture, for some years past been active in advocating measures of importance in relation to forestry. Bulletins and reports and gratuitous lectures and frequent conferences with congressmen have all had their effect in awakening an interest in this subject. There are several journals, notably *Garden and Forest*, which have exerted a good influence in behalf of tree protection, and such articles as THE ENGINEERING MAGAZINE has published lately on the great waste of timber still in progress are of value in properly educating the public mind.

From the condition of things here outlined it will be seen that the growth of an interest in forestry must be slow for some time yet, but I anticipate very great changes in the sentiment of our people and the formation of salutary laws by the close of this century.

AN EARLY ENGINEERING MAGAZINE.

By Hyland C. Kirk.

THE industrial and technical literature of to-day is so vast and so closely interwoven with the lives and work of all classes of our people that it is not easy to imagine a time, within our own century, when one or two small weekly journals practically supplied the demand for periodical publications devoted to the whole field of engineering. There had to be a beginning in this work, however, as in all other departments of human activity, and it may interest some of the readers of this Magazine to devote a few minutes to an examination of the contents of an early publication, which, while possessing merit, must have proved a labor of love rather than a source of profit to the publisher.

The Glasgow Mechanics' Magazine, a weekly journal printed and published by W. R. M'Phun, was established in January, 1824, and was one of the earliest periodicals devoted strictly to engineering science. *The Philosophical Magazine*, first published in London by A. Tilloch, in 1798, was devoted chiefly to translations of scientific articles from the French, while the Edinburgh journals of Brewster and Jamieson treated more of the progress of discovery in general science than of applied mechanics. *The American Mechanics' Magazine* began publication on February 5, 1825, and appeared for the last time on February 1, 1826.

The *London Mechanics' Magazine* was founded in the year preceding the establishment of the Scottish journal,—in August, 1823,—but was hardly equal to it on the score of attractiveness. This is conceded in a controversial article printed in the London magazine on July 10, 1824, in the following style: "The Glasgow magazine, though not sold for the same price, is printed on a finer paper and in a more showy manner than ours; but then it does not, on an average, contain one-half the quantity of matter, nor one-half the number of illustrative engravings, that the London magazine does."

To this the Glasgow journal replied: "Let any one compare the two magazines, and he will find that 'on an average' there is as much matter in the one as in the other, and that the London magazine contains no illustrative engravings at all, but only woodcuts, whereas the Glasgow one has, in general, a very fine illustrative copper-plate engraving, and a number of woodcuts alternately in each successive number." These engravings would be likely to attract any reader of to-day so fortunate as to meet with a copy of this truly excellent periodical. It appears to have been edited anonymously during the year 1824, but the management was changed in the second year, as indicated by the following head from the magazine :

THE GLASGOW
MECHANICS' MAGAZINE,
CONDUCTED BY
A Committee of Civil Engineers and Practical Mechanics.

> " From scenes like these old *Scotia's* grandeur springs
> That makes her lov'd at home, rever'd abroad :
> Princes and lords are but the breath of kings,
> ' An honest man 's the noblest work of God.' "—*Burns.*

No. LIII. *Saturday, 1st January,* 1825. Price 3*d.*

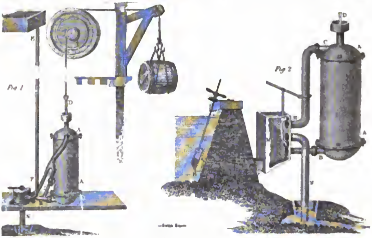
This magazine ran through 143 weekly numbers, making five volumes, when it was discontinued. The only valedictory to be found is in the motto quoted on the title-page. This motto was customarily changed from week to week, and in the last number this quotation from Mr. Brougham suggests, doubtless, something of the publisher's state of mind in relinquishing his work :

> The people themselves must be the agents in accomplishing the work of their own instruction. Unless they deeply feel the usefulness of knowledge and resolve to make some sacrifices for the acquisition of it, there can never be any reasonable prospect of this grand object being attained.

The five volumes were republished in 1835-36, and these reprints are occasionally to be met with, but a copy of the original edition is a rarity indeed The magazine is of interest now chiefly (1) as showing the condition of engineering science three-quarters of a century ago ; (2) as showing the origin of modern-class instruction in mechanics ; and (3) as illustrating inventions peculiar to the Scottish people.

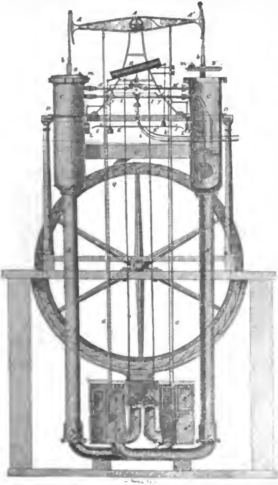
At that period great activity prevailed with regard to mechanical improvement and invention, stimulated by the successes of Watt, Franklin, Arkwright, Fulton, Bell, Stephenson, Davy, and others. New motors and new applications of motive power were being diligently sought for. Though steam was a favorite subject of experiment, no field was left unexplored. Two illustrations are reproduced of engines to be operated otherwise than by steam, which at that time seemed to possess some promise of value.

Harriot's siphon engine, used for raising and lowering weights, combines the power of the siphon with the direct pressure of a column of water, so that each alternately acts on the upper and lower part of a piston within a cylinder, reversing the siphon at each change. The two figures, illustrating the apparatus under slightly different applications of the power, will give a sufficiently clear idea of its construction. In each *M* represents the reservoir from which the water flows to the upper or lower part of the cylinder, as the operator adjusts the valves. The power of this engine is equal to a column of water of the same diameter as that of the cylinder, and equal in length to the height of the head together with the depth of the siphon-pipe below. The principle has had later applications in certain forms of the hydraulic press, elevator-engines, and other machines.



HARRIOT'S ENGINE.

The pneumatic or gas-vacuum engine, the invention of Mr. Brown, of London, was designed for raising water, and as shown in the engraving, for turning a water-wheel *Q*, by water discharged from the tank *O*. By the combustion of gas in the cylinders *C, C* lighted alternately by external flames at *L*, a vacuum is produced alternately in each cylinder, forcing the water through the pipes *P, P*, and up the mains *E, E*, whence it is discharged into the tank. The floats *F, F*, which rise and fall with the surface of the water in the chambers below, act on the walking-beam above to cover and uncover the cylinders. In the language of the description, given, "It is therefore the extinction of the flame by closing the top of the cylinder which actually produces the vacuum ; while at the same instant the water from below rushes up with vast rapidity to fill its space in the cylinder ; at the same time driving out the gas of the combustion by means of the small valves in the cover opening outwards. The water is discharged from the cylinder into the trough by admitting the atmospheric air through the horizontal pipes *M*, *M*." The editor, commenting upon this apparatus, regards the result as produced partly by the rarification of the air, though three-fourths due to the combustion of watery vapor, which occurs when the gas is put out and the cylinder begins to cool. He adds : "Properly speaking, Mr. Brown's engine is a steam-engine, and not a vacuum engine, as it has been called." This criticism, however true it may be, illus-



BROWN'S GAS-VACUUM ENGINE.

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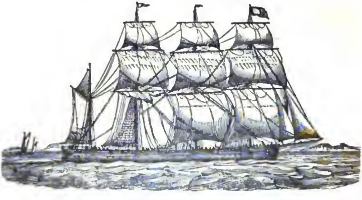
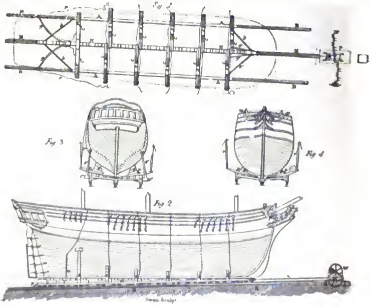


THE FOUR-MASTED AMERICAN SHIP "COLUMBUS."

trates probably something of the zeal manifested at the time for Mr. James Watt and his great invention.

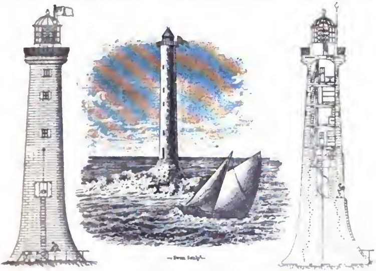
Among devices of an eminently practical character illustrated in the magazine, and which for the most part are set forth with



MORTON'S PATENT SLIP.

sufficient clearness to show their workings without further explanation, are the screw-machine of Angus Mackinnon, of Glasgow, the printing-press of Mr. Medhurst of London, and Morton's slip for repairing vessels. Each of these well illustrates the stage of the art to which it belonged, at the time.

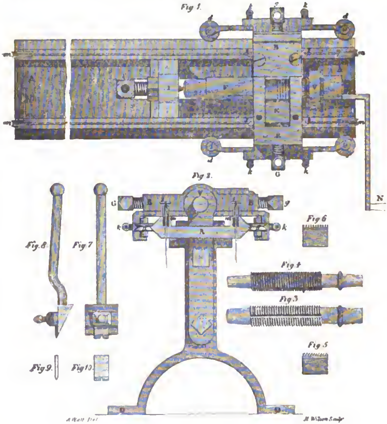
Many references are to be found to ships and nautical affairs. A woodcut of the *Columbus*, the largest ship then afloat, appears in the magazine for November 13, 1824. This vessel was 300 feet long, with 50 feet breadth of beam, and 30 feet depth of hold. She registered 3690 tons, and carried a cargo on her first voyage from Quebec to Liverpool of 6300 tons of pine deals and staves. The voyage began September 12, and anchor was cast at 3 P. M. on November 1. A work of greater interest to the nautical world is that of the Bell Rock lighthouse, built during the first dozen years of the century by Robert Stevenson, on the famous Inchcape rock off the east coast of Scotland. Still one of the great lighthouses of the world, it is unique in the fact that revolving bells are used as well as a revolving light in the turret, the former being of great service in warning vessels during fogs.



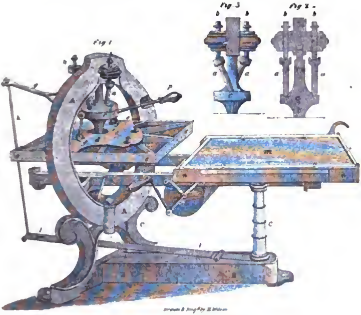
THE BELL ROCK LIGHTHOUSE.

The great interest in the subject of steam at that period is shown in the fact that, while some twelve articles scattered through the volumes are devoted to barometers and atmospheric pressure, six to bridges, twenty-seven to the art of bleaching, ten to clocks,—including clepsydras,—twenty-nine to electricity in its various forms, thirteen to the subject of light, ten to heat and thermometers, and eleven to weaving, no less than fifty-eight are devoted to steam and the steam-engine. Twenty of these articles refer in some way to steam navigation, embracing discussions and controversial letters as to who invented the steamboat, the claims of Fulton, Bell, Miller, and others being considered.

There is a report of the meeting held on Wednesday, November 24, 1824, in the city of Glasgow, "to consider the best means of



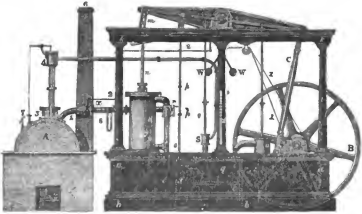
MACHINE FOR MAKING AN ORIGINAL AND PERFECT SCREW.



MEDHURST'S IMPROVED PRINTING-PRESS.

promoting a subscription for erecting a monument to the memory of James Watt." Mr. Watt was a native of the neighboring city, Greenock, and made his great invention while working at his trade as an optician in Glasgow in the winter of 1763-64. He applied for a patent in 1768, after thoroughly proving the efficiency of his device, through the aid of Dr. Roebuck, by erecting an engine at a coal-mine at Kinneil. London, Edinburgh, Greenock, and some other towns had already paid their tribute of admiration to the genius of Watt, but Glasgow, as if verifying the saw, "a prophet is not without honor save in his own country," had remained silent. This tardiness was explained at the meeting by the Lord Provost, who presided, in the statement that "many gentlemen entertained the idea of promoting the erection of one grand monument to his memory in Westminster abbey, in preference to anything of the kind here or elsewhere. This idea, however, on trial had not succeeded, and would therefore fall to be superseded by (he trusted) the more successful efforts of this day." Nearly every speaker who followed, including Professor Jardine, Mr. Monteith, Kirkman Finlay, Mr. Ewing, William Smith, Dr. Thomson, Mr. Houldsworth, and Dr. Ure, had been a personal friend of Mr. Watt, and the interest is in nowise lessened by their accounts of conversations with him.

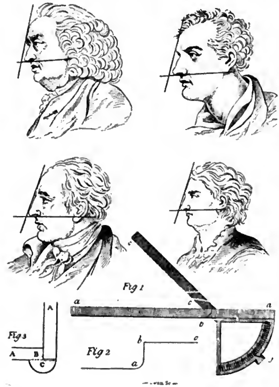
"When speaking of his great and uncommon qualities," said Professor Jardine, "I cannot forget his modesty and his simplicity of manners. Speaking once upon his great invention, I heard him say 'that, when it was analyzed, it would not appear so great as it seemed to be.' 'In the state,' said he, 'in which I found the steam-engine, it was no great effort of mind to observe that the quantity of fuel necessary to make it work would forever prevent its extensive utility. The next step in my progress was equally easy, to inquire what was the cause of the great consumption of fuel; this too was readily suggested, namely, the waste of fuel which was necessary to bring the whole cylinder, piston, and adjacent parts from the coldness of water to the heat of steam no fewer than fifteen to twenty times in a minute.'"



WATT'S TRUE MONUMENT—THE STEAM-ENGINE.

Dr. Ure referred to a conversation on a kindred subject: "'As to the latent heat of steam,' said Mr. Watt to me, 'it was a piece of knowledge essential to my inquiries, and I worked it out myself in the best way that I could; I used apothecaries' phials for my apparatus, and by means of them I got approximations sufficient for my purpose at the time. With them I ascertained the two main facts about steam: first, that a cubic inch of water would form about a cubic foot of ordinary steam; and secondly, that the condensation of that quantity of steam would heat six cubic inches of water from the atmospheric temperature to the boiling-point. Hence I saw that six times the difference of temperature, or fully 900 degrees of heat, had been employed in giving elasticity to the steam; which must be all abstracted before a complete vacuum could be produced under the piston of the steam-engine.'"

Dr. Ure, in a lecture given in aid of this monument fund, on December 20 following, well illustrated the greatness of Watt's invention by showing that the great pyramid, weighing 10,666,666 tons, and which, according to Herodotus, employed in building the whole available population of Egypt for twenty years, could have been built by means of the steam-engines then existing in Great Britain in less than five hours. "The knowledge of the laws of nature," said he, "arms our feeble hands with her most gigantic forces. How many populous and flourishing cities have been created by the genius of Watt! What were Birmingham, Manchester, Nottingham, Leeds, Preston, Glasgow, and many others, before his engine gave them vitality? And what would become of them were it to disappear?"



THE FACIAL ANGLE.

The following prophecy uttered toward the close of his lecture seems to have been verified reasonably soon : "The time is not far distant when chariots winged with fire shall be seen flying over metallic pavements through all the populous districts of the empire, transporting travelers and merchandise with amazing smoothness and velocity."

HATTON'S CHAMBER FLUTE-ORUM.

Though Mr. Watt's patent on the steam-engine included a claim for propelling carriages, he never constructed a locomotive. As the changes in mechanism from the engine which he did make to the railway engine were not radical or difficult, a number of locomotives by different inventors were soon forthcoming. Four of the articles on steam refer especially to locomotives.

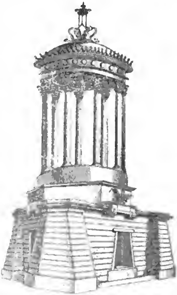
In the last volume of the reprint is an account of the opening of the railway between Liverpool and Manchester in 1829, and also of the unfortunate accident in which Mr. Huskisson, home secretary in the British cabinet, accompanying the Duke of Wellington and Sir Robert Peel, was run over by the "Rocket" engine. This accident seems to have been due largely to the inefficiency of the reversing gear to stop an engine moving at a comparatively slow pace. The "Rocket" had been constructed by George Stephenson, the successful competitor in securing the prize offered on that occasion for the best locomotive. Mr. Stephenson, deeply grieved at the accident, placed Mr. Huskisson on board the Northumbrian engine and, acting as engineer, conveyed him fifteen miles in twenty-five minutes, a most marvelous achievement at the time. Mr. Huskisson died that night at Eccles. The greatest speed on the trial trip of trains was one mile in 2 minutes and 6 seconds, the slowest speed one mile in 4 minutes and 57 seconds. There were eight engines in the procession, each drawing four carriages and from sixty to ninety persons in each train. The first conveyance of freight along this railway did not occur until December, 1830, when the total weight, "including eighteen wagons and engine," was eighty tons.

Natural history notes, mathematical problems, chemical experiments, questions of hygiene and the personal equation, are numerous throughout the volumes. Under the last head is a table of voice compass as compared with the range of musical instruments, deemed sufficiently important to be adopted by Knight in his "Mechanical Dictionary"; also the "faciometer," an instrument by which those who wish to be particular may measure the intellect of their friends. This instrument is shown in connection with the profiles of Dr. Johnson, Lord Byron, Sir Isaac Newton, and John Kemble.

In discussing the proposed monument to Watt, another question was incidentally raised as to whom the merit belonged for founding mechanics' institutions. A writer, "W. G." (probably Mr. Gardner, secretary of the mechanics' class), had occasion to say: "Anderson's Institution, of which I have the honor to be a member, has the distinguished and undisputed honor of being the parent of all the numerous Institutions that are now established in the kingdom for the instruction of mechanics; and it ought also to be the first in doing homage to the memory of that departed worth and talent which was fostered by the very hand that laid its foundation. The very man that founded this noble Institution twenty years before any similar one existed was the friend and companion of the illustrious Watt, and, had not our venerable founder, Professor Anderson, required his assistance in a very small matter, the steam-engine of Watt, and the consequent wealth and prosperity of our country, as well as the glory of this day, would never have had an existence. . . . To Professor Anderson may be traced the origin of all those Mechanics' Institutions which have since arisen in Britain, an honor which has hitherto been ascribed to another individual."

This called out a rejoinder from a correspondent "B." (**Hugh** Barclay, Esq.), who said: "The world has hitherto imagined **Watt** to be the improver of the steam-engine, and Dr. Birkbeck the founder of schools for the education of mechanics. But henceforth, on the showing of W. G., the 'distinguished and undisputed honor' must be awarded to Professor Anderson. I hate controversy much, but I hate injustice still more, and will not see Dr. Birkbeck (the 'individual' alluded to had W. G. chosen to speak out) thus gratuitously stripped of his well merited honors."

Dr. Birkbeck was then living in London and did not answer letters addressed to him on this subject, even those from his own supporters. The question seems to have been very thoroughly settled by a writer who subscribed himself "Aliquis." It appears that Mr. Anderson, professor of natural philosophy in the University of Glasgow for forty-one years prior to 1795, was accustomed to visit the workshops of artisans and to give them such information as was likely to be beneficial in their respective trades. The idea then occurred to him that, if a class were opened to which they could be admitted, it would greatly promote their knowledge in the different arts. Accordingly he opened a class upon Tuesdays and Thursdays at 8 P. M., to which the public were admitted. In a short time, "within the walls of Glasgow College, was there a large class of operative artisans receiving instruction in a science which before that time was inaccessible to the public." So "to Professor Anderson may be traced the origin of all those Mechanics' Institutions which have since arisen in Britain."



MONUMENT TO BURNS AT AYR.

Among the architectural illustrations is one showing a monument to Burns,—a structure which was located on a "brae" near the "banks" of "Bonny Doon," with "Allowa's auld haunted kirk" on the opposite side of the road, a little to the right.

THE PAST AND FUTURE OF ENGINEERING.

By Gordon B. Kimbrough.

IF an observant person were asked what art is most nearly related in its evolution to modern civilization, he would answer without much hesitation by saying that it is the art of the engineer. Esculapius, in the practice of his art of healing, gave pills, or their substantial equivalent, thousands of years ago; and though medical men have made some discoveries since then, and added an indefinite number of new remedies to the materia medica, their art has not radically changed. It is to be feared even that they have made much less progress than they are ready to claim; for though they assure us that the average duration of human life has been prolonged, the difference has not been sufficiently great either to be observed in history or to invalidate a certain counter claim that might be advanced. It may be assumed that, if it be true that human life has been prolonged, the improvement is due more to civilized living habits and the physical evolution of the race than to medicinal skill. We hear a great deal of learned talk about *bacilli*, and the doctors tell us that they have discovered the germs of disease. The very editors of some even of the most pestilential newspapers enlarge upon this subject as a means of displaying their scientific accomplishments. But Professor Koch failed signally in the attempt at utilizing his discovery in the treatment of consumption; and his failure has left him open to the suspicion that he has not discovered the germ of disease after all, but only the germ of the maggot, that final product of every fatal disease. We cannot say with certainty, therefore, that the art of healing has gathered much from human progress in the sciences of civilization, though in the face of all the claims presented in its behalf it may seem heretical to doubt. Surgery is unquestionably modern in its highest exploits, and quinine has proved to be a wonderful discovery; but the surgeon's control over human affliction is exceedingly restricted, and there is good reason to suspect that quinine was the contribution of a less than semi-civilization. Indeed, so questionable have been the triumphs of the art of healing that were due to generally advancing knowledge that it is not many years since the quack who announced himself an "Indian doctor" became a successful alchemist, able to transmute his wampum and feathers into refined gold. Even now the doctors think it necessary to make war on those eccentric persons who believe that faith is better than physic.

But let us leave the medical men alone. They are having enough to do in the protection of their *bacilli* without assuming any additional responsibility, and the arts more intimately related to the engineering art in their structural features will serve the purposes of illustration just as well as the art of healing. They may not be quite so old as the art of the medicine man, but they are old enough.

Turn, then, and look at the art of building. But the very first glance at architecture carries the eye almost beyond the circumference of modern civilization, and causes it to rest upon a renaissance, a medieval, or an antique world. It is doubtful if there is anything distinctly modern in the art of architectural building except its aberrations and its metallic ligaments. The best probably that any new architect will ever be able to accomplish on lines that are not engineering rather than architectural will be found in modern modifications and adaptations of ancient forms. It is a question if architecture, strictly considered, has not been rather corrupted than refined by its contact with modern civilization. We shall not find in the art of building anything to take from the engineer his preëminence in the development of civilizing forces.

Perhaps painting will serve us better. But here, again, we have something that is confessedly not modern in any of its essential features except possibly its choice of subjects, or a partial dependence upon certain mechanical processes that tend rather to the degradation than to the elevation of art. The modern painter, like the modern doctor, may insist that he has become learned ; but it must be said in the one case as it was said in the other that the fruits of his learning are not clearly manifest. The works of the Grecian painters have long since perished ; but we know that they were thought superior to the works of the Grecian sculptors even in form, and the works of the sculptors still remain the standard of excellence by which all modern works of sculpture must be tried. They are the models in drawing, too, for modern painters. We must assume, therefore, that, when the modern painter tries to measure his growth by a comparison between his own works and the works of the medieval or rather renaissance period, he is not looking far enough backward to estimate his true proportions. As to the art of sculpture itself, however skilful a few of the modern sculptors may have become, it is rather an antique than a modern art, unless it may be said that modern sculpture differs from ancient sculpture in its inspiration. The former is more monumental than the latter, and it makes its demigods out of commonplace heroes.

In this vein we might survey almost the entire field of art, including its literary annex, and, except among a few of the minor decorative arts, find little or nothing that can be claimed as distinctively modern and free from the necessity of borrowing from antique achievements. But there is one exception. In the engineering art we find an example of a constructive industry which the Romans and other people of antiquity practised. Yet from their achievements we can borrow little or nothing that is worth crediting. The Roman roads have remained a marvel of constructive energy and great resources down to the present time; but they represent an agency of transit and transportation that is passing away, and which is destined at no distant day to disappear utterly from the territory of every civilized nation. So, too, are we bound to believe that the ancients had great mastery over mechanical forces, that they were prolific in mechanical expedients at least. They could not otherwise have reared the vast structures that have been the wonder of the world. But their expedients would hardly serve a people who can lift great ships out of the water like toys. As to the dike-building engineers of antiquity who set the River Po on edge, their achievement was not sufficiently commendable for imitation, although the people of the Mississippi valley have not yet escaped from their malign influence.

Against this general disparagement of the engineering performances of antiquity may be set the aqueducts of Rome; but it cannot be admitted that these devices for supplying water to large cities illustrate a good principle in engineering. They are imitated in modern times only because the political octopus always sets itself against both progress and economy. In the first place they were conceived before the steam engine and the pump had made accessible the vast reservoirs of unadulterated and cool water hidden beneath the surface of the earth, and are therefore fundamentally wrong. In their modern adaptation they are simply sewers for conveying the drainage of barn-yards, and fields dotted with dead animals, for domestic consumption in towns, and on its way their supply is further contaminated by the floating carcasses of dead and rotting fish, decaying vegetable matter, and every conceivable filth that river water contains. We want no contaminated river-water in towns except for mechanical purposes; and the quantity needed could be supplied without any elaborate and costly adaptations of the stone or brick aqueducts of Rome. For all domestic uses except washing and cleansing we should have well-water drawn through separate pipes and distributed through separate reservoirs. The city of Brooklyn has both sources of supply, and it obtains approximately 50,000,000 gallons daily of river- and swamp-water, properly proportioned with barn-yard and dead animal solutions, and 25,000,000 gallons of pure well-water. But owing to the Brooklyn politicians' relish for mixed drinks probably, the total supply is distributed through a common reservoir. The people of Brooklyn, like the people of Hamburg, are not permitted to take even their drinking water straight.

But the dike builders and the aqueduct builders of modern times are antique survivals; and they hardly count among the army of engineers who are leading in the latter-day industrial march. The field of the modern engineer is widely diversified, and his preëminence over his ancient prototype is due to his versatility.

It is easy to understand the causes for the almost complete enfranchisement of the modern engineer, and for his distinctively original characteristics. They are found in the first place, after the invention of the steam-engine, in the larger use of iron as a material in construction, and in the second place in the discovery of explosives. The steam-engine had almost revolutionized the art of the civil engineer before the beginning of the last half of the current century; and the destructive power of cannon balls and other long-range missiles has compelled the art of military engineering to find cover against something more formidable than the missiles of the catapult or cross-bow. The discovery of explosives, too, has had its effects, and very remarkable effects, in the evolution of civil engineering, making possible the execution of works which the Romans could not even have conceived. The removal of the obstructions to navigation in Hell Gate, the modern treatment for such obstacles as Scylla and Charybdis, furnishes a case in point.

The engineer of to day is to be called the chief workman of the period. He not only builds our railways, opens our mines, and protects us, or pretends to protect us, from the destructive floods of our rivers, but he has taken such pervasive possession of the art of house building that the architect is compelled to play only in the rôle of the decorator. What lunatic Cæsar, baffled at the attempt at subjugating Scotland, would ever have conceived of a cantilever bridge to span the obstructing arms of the sea, or of penetrating the Highlands with steel roads equal to the transportation of an average Roman army in a few hours to the spot where stands the house of the more modern but still ancient Johnie O'Groat? Or what daft Pericles, had he been with Hendrick Hudson in New York Bay, would ever have thought it possible to find on the swampy surface of lower Manhattan Island a suitable foundation for a half-dozen repetitions of the Acropolis piled the one upon the other? The engineer alone of all other men is doing work in construction that leaves antiquity so invisibly in the rear that it is unable to offer a single suggestion that can promote the success of his operations.

Yet the work of even the modern engineer is only just begun. He has been erecting merely the skeleton of a figure yet to be clothed with flesh and covered with arteries through which will flow the life blood of a newly quickened being. The forces long known have only paved the way for the introduction of a new force destined to render all past achievement preliminary to the work to come. All that steam has done it will now be called upon to repeat infinitely through a new agent until its power is made almost as pervasive as the air.

Electricity may be said to have given a new birth to the art of engineering. Heretofore the engineer has not been considered an inventor in the sense that renders inventions patentable. He has been an inventor in his way, the inventor of structural processes and of mechanical expedients; but when it comes to the construction of machines to render his operations fruitful, he has been dependent upon the exertions of men working in a distinct field of construction. It may almost be said, indeed, that his devices have been supplementary to the work of the inventor; for though the railway preceded the locomotive, just as the ship preceded the steamship, the earliest railway was a device hardly to be dignified with the name engineering until the invention of the locomotive had called for its extension across rivers and through mountains. So, too, with the art of military engineering. It was the cannon ball and the destructive fire of musketry that developed the earthwork, the mine, and all that science of siege and defense that directs

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the hand of the military engineer. But the relations of engineering to invention must be radically changed now that electricity has come. The new agent will compel the engineer and the inventor, like the engineer and the architect, to pool their issues in a single head.

This may need a little amplification. The steam-engine, notwithstanding its wonderful resources, is a very unwieldy piece of workmanship. It has been trained to run rapidly enough along lines of parallel steel rails, and it can move all over the world in the interior of a steamship. But elsewhere it is a chained giant, only to be moved with difficulty, and its ability to distribute its forces is limited to the length of a shaft. Its field, therefore, is restricted, and it is fitted only for special tasks. But the electric motor is fitted for the performance of any task which machinery can be made to perform, while, at the same time, the appliances for the distribution of electrical power are at once so simple and so complex that there is more occasion for the inventor than for the engineer—as engineering duties have been heretofore conceived—to preside at the installation of the plant. In this fact we find a suggestion of what the engineer of the future must become if he would master his art and be in the highest degree successful. He must not only distribute the power, but he must enable it to work through an incalculable number of implements of his own device.

The performance of agricultural labor, soon doubtless to be attempted by electricity unless the farmers are the slowest men on earth, offers a chance for illustration. There will be no difficulty in conveying the electrical current to the farms. It will run along the highways, and transport both the farmer and his produce in its passage as soon as he will provide the way; but when it has been delivered at the farm, it will enter a field which is yet to be cultivated. After it leaves the highways, where it can be made to operate through adaptations of machinery already devised, it must be trained to work at the plow, at the harrow, and at every implement used by the farmer that can be operated by any other agency than the hand. But the machinery for farm labor is yet to be prepared; and it will be a poor triumph for the engineer to be able to say that he has provided the expedients for distributing the power, and left to other men the task of making it in the highest degree useful.

Hereafter the invention of machinery must be a part and a chief part of the training of the engineer. Men speak of the electrical engineer, of the mining engineer, and of the mechanical engineer as well as of the civil and the military engineer. But we could speak with just as much propriety of the architectural engineer, or the marine engineer, meaning by the latter designation not the men who drive marine engines but the men who build ships. Strictly speaking, there are but two kinds of engineers in the world, the civil engineer and the military engineer ; and it is curiously suggestive of a lack of intelligence on engineering subjects when we see the latter placed in charge of the duties of the former by official authority without as much preliminary experience as would be necessary to make a good house carpenter. In the distant future, when all the swords have been beaten into plowshares, there will be but one kind of engineer extant. He will be the mechanical or industrial engineer, and, known simply as the engineer without any specializing prefix, he will be the most ubiquitous being on earth.

For the present, the most promising agent for the industrial engineer is electricity. We know not what new forces the future may bring forth ; and while so much remains to be done in utilizing the resources of electricity, we have little reason to care. It may be that men will one day visit the planet Mars, if they care to waste time on a 40,000,000 mile excursion through space. But the living generation can find abundant entertainment nearer home. Our explorations for the present may very well be limited to the rural districts of our own earth, and the engineer should not be satisfied until he has carried electricity to every rural household.

ELECTRICITY.

Conducted by Franklin L. Pope.

IN an article in the *Independent* Professor F. B. Crocker, of Columbia College, says that the young man who takes up the study of electrical engineering with the intention of working hard, and who takes a real interest in his work, is almost sure of ultimate success, but that one who enters it simply because he has no taste for other work, or because he thinks it is going to be an easy way to make a living, is likely to meet with disappointment. The failures in electrical engineering have been sufficiently numerous, but they have usually been cases of men who have had an imperfect preparation, have not been sufficiently determined to succeed, or who have been lacking in industry. Professor Crocker insists strongly upon the importance and necessity of a thorough preparation in a scientific school. It is, as he says, practically impossible, now that the art has become so thoroughly specialized, for a young man to acquire anything approximating a thorough knowledge of this most difficult subject while engaged in ordinary industrial employment. He emphasizes the fact that almost every man who has achieved success in the electrical field has been one of the quick-witted sort, such as are held by our Connecticut friends to be the possessors of that indescribable qualification known as "gumption." Moreover, there is required above all things, in dealing with electrical forces, a man who is careful, exact, and conscientious, in small things as well as great.

A DIRECTORY of the electrical industries recently issued exhibits in a most striking manner the rapid growth and extended development of this department of modern progress. It appears that more than 1850 of the cities and towns of the United States are now supplied with central-station electric plants, while the isolated plants number several thousands more, these being apparently in special favor in the textile industries; the street-railways using electric power now number more than 500. more than 50 different establishments, some of them very large ones, are engaged in the manufacture of dynamos; while the production of insulated wire and other miscellaneous supplies is enormous. It seems almost incredible that such an industry could practically have grown up as it has within the past fifteen years.

THE esthetic and decorative possibilities of the incandescent lamp are only just beginning to be appreciated. One of the most successful efforts in this direction, in a small way, is the lighting of the Long Island Sound steamer *Puritan*, in which the wreathing of the pillars with a spirally disposed and graceful trailing vine of hammered metal, of which the lamps form the blossoms, produces a peculiarly unique and pleasing effect. The most successful achievement thus far in this direction however, is generally considered to be the interior of the church of St. Francis Xavier in New York city, in which the intricate renaissance decoration forms a most harmonious and admirable groundwork for the handiwork of the electrical artist, and one of which he has availed himself with the most picturesque and pleasing results.

ST. LOUIS boasts of one of the largest electric central stations in the world. It has 19 boilers, more than 5000 horse-power of engines and dynamos, and consumes nearly 100 tons of coal per day. The dynamos are located on the third floor of the main building, where no less than 7 of these machines may be seen at work in a single room. The switchboard is 60 feet long. The area of the district served from this station is 50 square miles, within which are 2100 municipal street lamps supplied through 532 miles of wire. There

Google

are, besides these, 1500 commercial lamps, with 240 miles of wire, making an aggregate of 3600 arc lamps. From the same station an area of 30 square miles is supplied by the alternating system with 20,000 incandescent lamps of 16 candle-power each, some of which are over 12 miles distant. Finally there are 20 miles of wire in the power circuits, to which thus far about 250 horse-power of small motors have been attached, working at a potential of 500 volts. All the wires are overhead.

In a recent lecture Dr. Silvanus Thompson stated that none of the gas-meters now in use are capable of indicating one-tenth part as correctly as the electric meters now generally employed in connection with central lighting stations. American electric meters are acknowledged to be the most satisfactory of any, and are used in vast numbers in the European systems.

Professor E. P. Roberts, writing in the *Electrical World* on the designing of central stations for electrical distribution, says that there are few towns of any importance in which it is not now possible to install an electric plant which will pay a handsome return on the necessary investment, provided the plant is well planned and constructed, and efficiently operated. This has been rendered possible in part by the increased commercial efficiency of the apparatus now constructed by the leading manufacturers, and in part by the great decrease in price of apparatus within the past two or three years. Professor Roberts very justly criticises that species of economy which would not hesitate to pay an architect $5000 to design a $100,000 office building, even after the dimensions and general plan of the work have been determined upon, but which would begrudge an equivalent compensation to a competent electrical engineer to give advice respecting the location, dimensions, and arrangement of an electric plant costing an equal or even a much greater amount, which requires even a rarer quality of skill than much that is found in the profession of architecture. We entirely agree with him in his conviction that a competent man, taking plenty of time to look over the ground and consider the various conditions, could design a station costing 10 per cent. less to operate than if the same person had been compelled to do the work hurriedly, or if it had been done by an incompetent man. Is it not therefore, he inquires, the part of wisdom to pay 10 per cent. of the cost of a station to have it properly designed, if a saving of 10 per cent. per annum in the expenses of operation may be thereby realized? It is notoriously true in every business of a technical character that good advice pays by far the largest percentage of any portion of the investment.

An electrical encyclopedia has been projected by Mr. Park Benjamin, the publication of which will be undertaken by a prominent firm, provided sufficient encouragement is received from electrical engineers and others who would naturally be interested. Mr. Benjamin is undoubtedly well qualified to carry out the undertaking satisfactorily, and it is certain that a really good work of this kind is much needed.

The Post-Office Department in Great Britain operates between 30 and 40 telephone-exchanges. The aggregate number of subscriber's telephones connected with the Post-Office exchanges throughout the kingdom is only 5382. Metallic return wires have been used in all cases, since the first introduction of the system. The National Telephone Company, a private corporation, has nearly 50,000 subscribers, and pays the government £45,000 per year in royalties.

A very useful application of the electric light to railway cars has recently been tested in Boston, with satisfactory results. A 16-candle incandescent lamp and reflector are located just under the sill of each passenger car close to the steps. When the train arrives at a station after dark, the brakeman turns on the light, and the passengers have a clear view of the steps and the platform in the vicinity. The cost of this improvement is trifling.

THE Boston *Transcript* says that the cry of "incendiary" has been provoked by the mysterious fires which have occurred in that city during the past few months, and expresses a suspicion that the name of this incendiary is "Electric Wire." We referred in these notes not long since to the action of certain ignorant and superstitious inhabitants of a remote southern State, fifty years ago, who destroyed hundreds of miles of telegraph lines because of a similar "suspicion" that this structure had been the cause of a succession of "mysterious" droughts which had destroyed their crops season after season, but we had heretofore given the Bostonians the credit of having risen somewhat above the intellectual level revealed by the *Transcript's* remark. Our own personal observations have been sufficient to convince us that the succession of disastrous conflagrations which have visited Boston during the past few years have been directly attributable, first to a vicious and utterly unsafe system of building, and second to inexcusable negligence in guarding, by efficient inspection, against unnecessary risks. Only a few weeks ago we noticed in a large seven-story building in the heart of the wholesale district a central elevator-shaft sheathed with pine, with windows opening into every story; the bottom of the shaft was utilized by the engineer of the building as a place of storage for oil, and plenty of inflammable rubbish was lying all about. A match or a spark dropped into this mess would set the whole building in a blaze in an instant. In our opinion a city where such practices are permitted need not charge its disasters to mysterious providences or to electric wires. The *Transcript's* reasoning appears to be something like this: "Electricity is something the exact nature of which is unknown; the origin of the mysterious fires in Boston is something the exact nature of which is unknown; hence as things which are equal to the same thing are equal to each other, the origin of the fires is necessarily electricity."

IT has long been known that lead suffers from corrosion when buried in certain kinds of earth. It has been discovered that the water supplied to the city of Glasgow, which contains free carbonic acid, and which has been found to attack lead, can be neutralized by chalk, so as to correct the evil. It has therefore been suggested that subterranean electric cables encased in lead tubes might with advantage be embedded in chalk. In this country a small mixture of tin has been found to answer an excellent purpose as a protection against corrosion.

A WRITER in *Industries* (London) makes some very pertinent observations in reference to the flood of books on electrical subjects which has been pouring from the press during the past few years. He says they come in for review in shoals, and, when he has collected a clothes-basket full, he is compelled to spend a miserable quarter of an hour in reviewing them. They all seem to be alike, not only in their letter-press, but in having the same wearisome illustrations of obsolete machines; the only difference is in the errors introduced. The really good book, written by a competent author, is a rarity. The most common variety is the scrap-book, made up of clippings from the technical press. Even this might be very useful if the compiler knew anything about his business and could give a collection of articles written by different specialists on some particular branch of the subject. But as a matter of fact, if he has fifty papers on the subject—say of dynamos—of which forty-nine are nonsense, he leaves out the good one because it looks too simple and contains no mathematical formulæ, and inserts the other forty-nine. He then strings the whole forty-nine theories into one chapter, if he is a Frenchman, and into one sentence if he is a German, in perfect unconsciousness that each one is absolutely contradictory of all the others. Then there is the "Electric-Light-Popularly-Explained" family of books. These are easy to write, being simply a rehash, warmed over, of similar preceding books, and may be illustrated with any old woodcuts available, or with electrotypes from dealer's catalogues. Then there is the electrical pocket-book, containing a vast

.y of useless misinformation which
ly could ever possibly want, and so
infinitum. The interesting fact re-
s that after all a very short list will
all the really useful books relating to
ience of electricity and its industrial
cation.

the recent Electric Light Conven-
in St. Louis, Mr. L. B. Stillwell re-
ed that the central-station manager,
is buying energy in the form of coal
selling it in the form of light, and
ing it at every step of the process, is
g far more before the energy passes
ugh the dynamo than afterwards. He
nates that, out of each 1000 horse-
er bought in the form of coal, it is
esent possible to sell not more than
it 2.8 horse-power in the form of light.
e 930 horse-power is lost before reach-
the dynamo, and the rest afterwards.
ems clear, therefore, that the problem
heap electricity is in its final analysis a
lem of thermodynamics.

HE everlasting question as to why the
erican electric-light managers will not
storage batteries came in for a share
he discussion at the Electric Light
vention. Professor George Forbes, of
ndon, pointed out that the loss in using
age-batteries arose in part from the
t of installation, which is far in excess
he dynamos and machinery which they
lace, the loss of energy in transforma-
n within the batteries, amounting to 20
cent. of all the coal used, and finally the
vy depreciation account, which is gen-
lly admitted to be not less than 12 per
it. per annum. It is pretty safe to say
t, if the shrewd and sagacious men who
managing some of our largest central
tions were able to see any economy in
use of storage-batteries, there would
ve been plenty of them in use here be-
e this time.

IN a paper read at the Electric Light
nvention Mr. L. B. Stillwell remarked
at no perfectly general solution of the
onomics of central station operation can
worked out. Of 10,000 plants the fittest will survive and pay dividends, and central-station engineering will then consist of close study and careful analysis of the conditions and methods which have brought about the survival of these fittest installations.

MR. CALVERT TOWNLEY, in summing up an exhaustive discussion on the economics of the incandescent lamp, arrives at the conclusion that the profit falls off very rapidly for lamps either of too high or too low efficiency; in the first case, by the excessive cost of frequent renewals, and in the last by the excessive consumption of energy. This variation is more marked where current is dear and running expenses high. It is easily demonstrable that the long-lived inefficient lamp is a very expensive article to the consumer, and that too much weight has heretofore been given to the cost of lamp renewals, while not enough attention has been paid to the cost of energy. The fact is sometimes overlooked that there is nothing bought or sold in this world which does not represent energy, and that wasting energy is as bad as, nay, far worse than, merely wasting money. Money is a mere counter: energy is the thing that money stands for. The conclusions reached by Mr. Townley are gratifying in one respect at least, and that is that the possibility of increased profits in supplying light by electricity carries with it the implied possibility of reduced prices to the consumer, and correlatively, of a greatly extended use in comparison with other illuminants.

ONE of the subway commissioners of New York city is authority for the statement, made to a member of a Boston committee which has been seeking for light on the subject of placing electric wires under ground, that the arbitrary provisions of the New York law have worked great hardship to the electric companies. At least half the companies which were doing business at the time the subway commission was created are said to have been driven into bankruptcy. The commissioner said furthermore that the experience in New York had been that a great many consumers were unable to pay the increased cost of service rendered necessary by the increased cost of subway construction, and that this discontinuance of service had proved fatal to many of the smaller companies. He mentioned one subway, several miles in length, which cost $500,000 to construct, in which, up to the present time, only three ducts had been rented.

A BILL is before the legislature of Massachusetts providing that the question of permitting electric railways to cross steam-railways at grade shall be placed under the jurisdiction of the State railroad commissioners. The proposed legislation is favored by the managers of the more important steam-railways of the State. The evil of grade crossings of this character is rapidly becoming a very serious one, and ought to be taken in hand by the authorities without loss of time. The manager of the Boston and Maine railroad says that there are already more than forty such crossings on his lines.

THE city of Boston paid last year for electric-lighting $216,445 against $193,702 for gas-lighting. The number of electric lights maintained by the city is 1547.

THE town of Peabody, Mass., is trying the experiment of municipal electric-lighting. The plant has now been in operation for some months, and the results of the first four months' operations have been made public. The total cost of plant to date is given as $48,176.92. There are 149 1200 candle-power arc lamps, connected with 40 miles of wire, lighting 23 miles of streets, and supplied by 4 dynamos having a capacity of 48 lamps each. The figures of cost of operation appear to have been honestly made, which is more than can be said of any other municipal plant within our knowledge. The operating expenses include interest on $50,000 at 4 per cent.; depreciation on $30,000 at 5 per cent.; taxes on $35,000 at $15, insurance $195, etc. The lamp-hours per year are computed at 3128, and the average cost for four months ending February 1, 1893, is given as 2.19 cents per hour, or $68.72 per annum.

BY an oversight which we regret, a paragraph appeared in these notes last month to the effect that the managers of the World's Fair had resolved to close the exhibition evenings. In November last it was authoritatively announced by the president of the executive department of the Exposition that it was not intended to close the Fair on all evenings, but merely to reserve the right to close on particular evenings, should circumstances render it advisable.

PHILADELPHIA has about 500 miles of street surface railway,—more than any other city in the world. The change from animal to electric power now going on will probably make a difference of some millions of dollars per year in the profits of the company which has succeeded in obtaining the franchise. It looks at the present time as if the whole system would be equipped and running before the horse-cars have disappeared from any of the streets of New York except Broadway and Third avenue.

THERE is an important street-railway junction in Boston, where there is a wonderful maze of trolley wires overhead, from which circumstance the locality has received among the employés the picturesque designation of "the rattlesnake." One day last month something gave way in the internal economy of the reptile. I was shortly after noon, and the whol transportation system of the West En Company was utterly paralyzed for two o three hours. It is stated that a large number of generators at the central powe house were burned out. This, we believ is the first time that such an accident ha happened, and, as might have been e pected, it created considerable consternation for a time.

THE General Electric Company hav secured the temporary use of the Cresce Beach loop of the Boston & Maine Rai road near Lynn, Mass., for carrying out series of experiments in reference to t application of electricity to ordinary ra way train service.

MECHANICS

Conducted by Leicester Allen.

MECHANICAL resources have been very greatly extended during the past twenty-five years by the widening of the range of artificial temperatures attainable and maintainable. This range has been stretched out from both the positive and negative limits formerly reached. On the negative side temperatures of —210 C., equal to —334° F., are now reached and maintained for a considerable period by scientists in their experiments; and the examination of materials which at temperatures formerly practicable remained either gaseous or liquid, and which are either liquified or frozen at these low temperatures, seems likely to throw much new light upon the physical and chemical properties of materials in general.

Hydrogen, for instance, has long been suspected of possessing the character of a metal. Certainly there are certain metallurgic phenomena in which this gas plays a part that seem explicable only on this hypothesis. If, at the lower temperatures likely yet to be reached, this substance can ever be frozen, the question of its metallic character can probably be fully decided.

But it is the extension of the limit of artificial temperature on the positive side of the scale that has, as yet, increased mechanical resources, rather than the production of low temperatures. The temperatures of from 2500 to 3000° C.—the latter being equal to 5432° F.—are now as readily produced in electric furnaces as was half that temperature by means available twenty-five years ago. At the latter temperature most refractory substances, as for example lime, melt and run down like water. It is not beyond possible developments that nearly every substance known to man will, ere long, be brought into the class of practically fusible substances, that is to say, not merely reducible to a pasty plastic consistence like melted glass in glass-furnaces, but brought to a fluidity that will permit their being poured into molds, provided that any substance capable of standing up against heat of such intensity can be found for the molds.

AT a very interesting meeting of the New York Railroad Club held on February 16 at the rooms of the American Society of Mechanical Engineers, some things pertaining to automatic car-couplers now generally used on American railways were brought out in a topical discussion, in which many members of the club took part. It appears from this discussion that without a special appliance called the dead-block draw-heads are very liable to breakage. On the other hand, it has been asserted that the use of dead-blocks defeats the primary and most important purpose of automatic couplers, which was and is the protection of trainmen. The dead-blocks, receiving the shock when cars run together, protect the cars and reduce very much the breakage of draw-heads; but there appears to be a wide divergence of opinion as to whether they do or do not endanger the men. It came out in the remarks of Mr. C. A. Smith, who proposed the topic for discussion ("Should Dead-blocks be Applied to Freight-cars with Master Car-Builder's Couplers?"), that dead-blocks are in evil repute among many western railroad men, who have dubbed them "man-killers"; and even some of those who in the discussion advocated the use of dead-blocks admitted that they are dangerous if men are not careful. As Mr. Smith remarked, "men will not always be careful." Others regarded the dead-blocks as an element of safety not only to the cars, but to the men also. Mr. Rogers, who claimed to speak from extensive experience, said that, if he could have his way, he "would want good solid dead-woods on all cars, whether it was the vertical-plane coupler or the old link-and-pin." President Blackall pointed out that "a great many men have been killed by the draw-head being knocked in and the man being caught between the cars." The discussion, on the whole, seemed to favor the use of dead-blocks both as a protection to trainmen and to cars. Mr. Medenhall raised a point not brought up by any other speaker present. He said: "The great strain that a freight car has to stand is the buffing strain. If there are no dead-blocks to take that strain, it must be taken by the automatic coupler, which is hung below your sills, and, as a consequence, you find that when the strain is severe it will break your stringers at the body bolster and every one of them will go. If dead-blocks are properly applied, you get your strain through your stringers and in many cases the body of your car will be saved, whereas, if the automatic coupler took the shock, the stringers would all be broken."

FROM a quarter that commands respect comes the following communication. Our correspondent prefers to conceal his real name by signing himself "Willett." His complaint will be echoed by many who have had similar experience:

Mechanical Editor ENGINEERING MAGAZINE:

Manufacturers of machinery would save themselves and the men placing their machines much delay and trouble, if they would get out a special drawing for each machine showing everything necessary for placing and connecting it up. Take for instance a steam engine. A drawing is at hand, sent by the engine builder to the engineer in charge of erecting an electric light plant. The size of the steam pipe is given, but the figures for the location of the nozzle are not. The same is true for the exhaust pipe. The foundation bolts are located in a sort of a way, but neither their size nor the thickness of the bed-plate lugs are given. Information is absolutely wanting about the fly-wheel and the number of revolutions. The drawing is not even to scale; just a few figures are scrawled upon the blue print with acid.

From that miserable sheet the engine maker expects the engineer to design everything, placing on foundation, piping up, and connecting to dynamos, so that the engine will run economically and evenly, and cast great credit on its builder; and so that it will lead to the sale of several more of the same style of engines for a similar class of work.

Of course, the engineer can and does get at all of these things, by an endless amount of telegraphing and writing; but how foolish this is, when a single blue print from a tracing, requiring not more than one or two hours' time of a cheap draughtsman, would tell the whole story.

This trouble is especially noticeable when a large plant is being erected, and when boiler makers, engine builders, pump makers, and all the rest of the manufacturers are equally negligent. WILLETT.

Chicago, February 21, 1893.

GOLD- and silver-mining on the Pacific slope have been carried on about fifty years; and the output of the mines during that period has been without precedent in modern history. But railroads, bridges, etc., though gold may pay for building, cannot be built *of* gold at a cost that will pay a reasonable profit on the investment. The time may even arrive in California when iron roads may cost more gold than is consistent with such prospective earnings and profits as may reasonably be hoped for. The possibility creates a desire for cheaper iron. The *Mining and Scientific Press*, in a recent issue, announced that the want of cheaper iron on the Pacific coast has become urgent, so much so that capitalists are endeavoring to find in deposits of iron ore and coal in California the possibility of establishing an iron industry near enough to the Pacific to save the freights on iron from eastern sources, it being the cost of transportation that renders iron dear in the markets of the Pacific coast. While eager to encourage this attempt, the paper quoted, in its discussion of the subject, does not appear over sanguine that it will succeed; nor does it make a showing of existing conditions that appears very tempting to eastern enterprise. There is plenty of good iron ore on the Pacific slope, and it is asserted that coal suitable for working the ore exists there also; but as the means for economically bringing the ore and coal together t exist, and to all appearance are not soon to exist, the ore might as well Maine as in California as regards its nt availability. However, it appears astern capital is on the alert for any ble opening in iron manufacturing may arise. The journal named says " the Jones Creek iron mine, half a from Humboldt Bay, Humboldt ity, has been leased to eastern parties, intend to open and prospect the de- . Should developments justify, a further will be put up."

ere is, therefore, a big "if" in this ation. The proximity to Humboldt is an element favorable to success, as, furnace should be there erected, fuel d be brought by sea to the works, and shipment of the product could also be ea. However, this is yet "all in the ' and it does not yet appear how the l of gold is going to get much cheaper than it is now getting, unless some to cheapen transportation, not yet in it, should solve the problem. It is bable that the crops grown on the ferlands that skirt Humboldt Bay will g be a much greater source of wealth to ifornia than any iron industry that can developed in that beautiful region.

OMPRESSED air, as a means of transtting power from prime motors, has n brought into prominent notice rently by its adoption in the shops of the uerpel Switch and Signal Company, at . Louis, Mo. Illustrated descriptions of is plant, showing the arrangement of e prime motor, and the smaller comessed air engines with reference to the achines driven by the latter, have been inted in *The Iron Age* and other techcal publications. The plant, as designed r the special work of this shop, is a deded innovation in shop equipment. The rime motor is a Norwalk air compressor f the compound type, and of 35 horseower. This compressor forces air into a orage reservoir, from which the comressed air passes to the machine shop and attern shop through underground pipes, nd is there taken through overhead ranch-pipes to descending pipes supplying Kriebel engines distributed in various parts of the works for driving different tools. There appears from the description to be seven of these engines for large tools and one 6x14 engine for small tools. This kind of power distribution does away with line shafting as effectually as electric transmission. About the economy of the system as yet nothing can be said that is based upon experimental data; and until these are forthcoming many will entertain doubts that it can compete with electric transmission in this respect, although all will at once concede the advantages of cleanliness and convenience. The exhaust of so many air-engines will, without doubt, assist much in cooling and ventilation in sultry summer weather. In winter, unless provision be made for conveying the air cooled by expansion to the exterior of the shops, these exhausts may add to the expense of warming. It is believed that this is the first instance on record where an entire manufacturing plant has been organized to distribute the power of a prime motor by compressed air, and to apply it where and when wanted, by the use of compressed air engines.

THE idea that small differences in thickness of metal make notable differences in the transmission of heat through it when large differences of temperature exist between hot liquids or gases on one side and the cooler gases or liquids on the other side is not sustained by the laws of transmission of heat by conduction. Such effects are notable only when small differences of temperature exist between the substance that imparts heat to the thin conductor and the body that receives heat from the other side. In the case of locomotives worked under high pressure, it is possible that the temperature of the gases of combustion may approach so nearly the temperature of the water in the boiler before reaching the smoke-stack as to make the greater thinness of the ends of the tubes remote from the fire-box somewhat more effective. Unless, however, any increased efficiency in heat transmission be experimentally shown in the use of these tubes over that found to exist in tubes of the same thickness throughout and having also the same mean thickness, it may reasonably be doubted that the alleged superior efficiency exists, except in the case that some other assignable cause for increased efficiency appears plausible.

THE enormous mechanical energy in waves rolling in over a shelving beach has never yet attracted the attention it merits as a possible source of mechanical power. Now that electrical transmission of power has been carried to such a degree of practicability that a distance of from ten to twenty miles from the source of power is no bar to the utilization of water power at points within these or even greater limits, it appears that the same amount of science and skill that has been applied to the solution of the problem of mechanical flight should be able to give to the world the wave mill. A moment's reflection will convince any mechanical mind that wave-power enough, and a great deal more than enough, daily goes to waste on Rockaway beach, to supply New York, Brooklyn, and Jersey City, with the heat, light, and mechanical propulsion required by these cities for all purposes. A nearer but lesser source of wave-power exists at the Coney Island beaches.

ASSUMING that the problem of transmission of power is solved, as it is practically, though we may reasonably look for a large progress in this branch of electric engineering, the first step towards the solution of the problem of the construction of a practicable wave-mill is to find means for converting motion of very variable amplitude into uniform motion in prime motors.

The second step will be to provide means whereby an exceedingly variable supply of power may be stored for use, so that a uniform supply may be distributed to points where it is needed for useful work. In the carrying out of any such project very large wastes at the point of supply will be of little moment, since we should be drawing from a source that is at present all waste. When it is further considered that the origin of waves in bodies of water may be traced directly through their immediat
cause, the winds, to solar heat which cause
the winds, it is also made evident that w
should be drawing power from a primar
source that may be considered as infinit
and inexhaustible when compared with th
needs of mankind. Economy in storin
transmitting, and applying the powe
rather than the hoarding of such a pe
manent and generous supply, will deman
attention.

Professor Thurston has given us, in
late number of THE ENGINEERING MAG
ZINE, a graphic picture of the part playe
by wind-power in the history of advan
ing civilization. The introduction
wave-mills, if successfully accomplishe
would more profoundly influence the pr
gress of our race than any other hum
invention has ever done, with the sing
exception of the steam-engine.

A FIRE-BOX seam-protector devised
Mr. W. J. Davis, general foreman of t
Foxbury shops on the Pittsburgh a
Western railway, commends itself to sou
mechanical judgment as a useful innov
tion. The object of the device is to ke
rivets cool by the passage of air over the
from below. It is extremely simple bo
in construction and application, bei
merely a bar of 3″x1⅛″ iron bent to cor
spond with the contour of the interior
the firebox, at the place where it is desi
to protect a row of rivets, and held in pla
by a single ¼″ stud inserted at a po
about two inches below the top of the p
tector. The device is stated to have be
first tried on an old locomotive, and, h
ing proved entirely successful in stopp
leaks, it has since been applied to ot
old fire-boxes. The protector is made
cover only the leaky part of the seam.
burns out in about two months. The h
force exerted upon it would, in its abse
be expended upon the seam. Le
seams, thus protected, are said to have
six weeks without any leakage. W
would this not be good practice for
locomotives also? *The Railroad Gaz*
in its issue of February 3, gave a diag
illustrating this simple, practical dev
which seems, however, sufficiently c

prehensible both in principle and construction without such aid.

EVERY mechanic should fully realize that no reliance can be placed on the measurements of sizes or distances indicated on any caliper or gage used in any place whatever, where the precision is required to be absolute to standard rather than comparative to the means employed to indicate such standard. Such variations in ordinary machine-shops may be as much as .0005 of the size indicated, and this variation may be proved and should be tested by every practical man. Suppose that a vernier gage having twelve inches capacity be held at its widest opening between two parallel pieces of equal length in a vise, and a rod about one-quarter inch in diameter be fitted to it so that it just fills to touch the gage and no more, the rod being freely handled to warm it; then, if the vernier gage be removed from the vise and the rod be substituted for it between the parallel pieces, the gage being still freely handled to warm it, the length of the rod will be found to indicate much shorter, perhaps by one-hundredth of an inch.

UPON the value of training students in technical and trade schools for mechanical pursuits in advance of that sterner and more rigid training received in shops, there has been much diversity of opinion and much argument, the prevalent opinion being that such schools are very useful in certain directions, while in others they are greatly deficient. In an inaugural address delivered by Professor R. H. Smith at the opening meeting of the Mason College Engineering Society at Birmingham, England, this gentleman expressed the opinion that "the most difficult and tedious part of technical training" is the cultivation of what he styled "reliable instinctive faculties"; that in this "the technical schools can, at least, make a good beginning, and that herein really good practical results can be produced." His opinion of what a mere school training can *not* do is equally well put:

> What a mere school training can *not* do is to impart that habitual caution and careful accuracy which comes only from a sense of responsibility. The scholar pays his fee and thinks he does his whole duty if he submissively accepts the lesson for which he has paid the fee; he cares little whether he makes a blunder in executing the exercises which he has given him, knowing that the evil results of his blunder are for the most part confined to himself, and that there are no ulterior consequences to himself of any very grave or dreadful sort,—none such as would in the other place [work-shop] cause the foreman suddenly to blaze forth in language quite unfit to be heard within the sacred precincts of the college. Practically the worst that he can fear, as the result of his error, is the waste of so much material; and he has rather a habit of thinking that because he has paid a fee he has the right to waste so much material per day, the proper amount being settled by himself within his own private conscience.

A remedy for this is suggested by Professor Smith,—to wit, that students shall only be employed on real work, and held to account strictly for any carelessness in the performance of any part of work contributing to a general result, the same as though he were a shop apprentice. All who have thought much upon this subject will be likely to appreciate both the defect and the remedy proposed for it. The trouble will be in the practical application of the remedy.

The atmosphere of a school is totally unlike that of a workshop, as is tacitly admitted in Prof. Smith's allusion to the language a foreman would be apt to use to a delinquent apprentice. Students are the recipients neither of wages nor of the brow-beating that fall to the lot of apprentices in shops, and it may well be questioned by shrewd observers of the social ethics of shops whether the guying and ridicule to which heedless and slovenly youths are subjected as a penalty for their blunders is not the very best discipline for the cure of such faults.

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ARCHITECTURE.

Conducted by Barr Ferree.

THERE seems to be no diminution in those relics of uncivilized times,—architectural competitions. Every year some important mercantile building is decided by this cumbrous, expensive, and unnecessary method, which is as sensible as if a sick man were to send for a half-dozen doctors and promise to engage the one that would effect the speediest cure. How long this state of things is to continue it is idle to predict, but, being an unavoidable evil, it is clearly right to make it as little an evil as possible and to eliminate from it every possible suspicion of unfairness. Architectural competitions, unfortunately, are looked upon in so many quarters as perfectly natural and proper things that the methods of conducting them are very well known, very well understood, and, so far as the architect is concerned, very well systematized. A well-drawn competition program is a thoughtful document, embodying a multitude of details and requiring a wide acquaintance not only with the practice of architecture, but with the entire history of architectural methods. It is a document that cannot be drawn by every architectural practitioner, and, as might be expected in this era of specialism, we are gradually producing a small school of competition-program makers, who, if this system is to be continued, must, before long, exercise an influence on current architecture quite out of proportion to their merits. It is hard for the most conscientious program-maker not to infuse his personality into it, to indicate his own personal inclinations as to style and treatment, to tell the architect, so far as he dares, how to treat the problem it is only his business to indicate in the most summary fashion. Much of this is unavoidable, but the influence of this hidden and powerful force in current architecture is not to be despised. In the limited competitions which are now the fashion, the most careful scrutiny is exercised as to the architects who shall be invited to compete for it. Their merits and demerits, their advantages and failings, their good work and bad, are all passed in review and the very best selected. Yet who examines the program-maker, who questions his authority or his competency, studies his prejudices or makes allowances for his idiosyncrasies? He needs looking after as sharply as the architect. He may be, if he chooses, a most dangerous man.

The professional program-maker is a natural product of the competition system. Under our present architectural fashions he is more likely to be a teacher of architecture in an architectural school than a practising architect. For some reasons such a person possesses many advantages for the work. He is not distracted by the labors of actual practice; he has time to give to study for which the busy man of affairs can devote no moments. Years of exercise in criticisms of youthful drawings have trained his mind in critical methods, even though the material on which it has thriven has not been of the healthiest and most invigorating kind. All of these are distinct advantages, and, coupled with the fact that he has probably had much experience in these things,—else how could he be a professional program-maker?—make him a very proper person for this sort of work. But he has his disadvantages, as have most people and much architecture. The teaching of architecture, as the teaching of any subject, tends to keep the teacher's mind in a single rut. He views things from the academic standpoint, and in this country knows no architecture save that taught in the Rue Bonaparte. In other words, the architectural teachers of this country have so positively made up their minds that the system of the Ecole des Beaux-Arts is the only one to be employed in instructing young archi-

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that nothing else is considered neces- or their training. Instructors in con- ion must, perforce, keep pace with igantic constructive strides American tecture is now making, but the teacher art of architecture, as the more or- ntal side is often wrongly called, and is most likely to be the professional ram-maker, knows no architecture that of Paris and its world-famous ol. A person so trained is not in the fitted to draw up a program for a etition for a business building, for ex- e. What have orders, and columns, friezes to do with a business building? has only to look at those examples in h they occur to find an answer. The essorial Professional Program-Pro- r—to give him a stated title—is out uch with much modern work. Living single style, he sees solutions in it only, his program is drawn up accordingly. architect finding hints of the classic ngly stated in the program necessarily gines that he must follow them. And the Professorial Professional Pro- n-Producer helps along his own school orcing the use of his style, whether it eally suited to the problem in hand or . The retarding influence he can exert the progress of American architecture not always be recognized, but it is ertheless a fact. The creators of com- itions should examine his merits as well hose of the architects they invite before ting his work out upon a long-suffering ugh perhaps indifferent world.

F the antecedents of the professional gram-maker need to be looked into in ry well-ordered competition, the ante- lents of the jury should be not less care- ly studied. The deciding of competi- ns, as well as the drawing up of their grams, is rapidly falling into the hands the professors of architecture. Archi- ts, in active practice, are either taking rt in the competition, or do not wish to ve the time and thought necessary to the dging of a series of architectural designs. sides, the mental agony incurred in oking at atrocious designs is likely to terfere with the work of an artistic architect for some weeks to come. And so, the architects not being available, the jury plums fall to the professors. And people more unsuited to such work it would be hard to find. Professors, like other folk, have their prejudices and failings, their inclinations and preferences. They like one style, abominate another, and look with indifference upon a third. The style they like is doubtless the only one they know, since even a professor of architecture cannot know everything; certainly it is the one they are apt to judge by, because it is the best. Here comes a new element for the architect. He not only has a program drawn up by a biassed hand, but he knows that, if he wishes to gain a certain competition, he must follow the inclinations and prejudices of his jury. An architectural jury, unlike one in a court in law, does not judge by facts, but by prejudices. If an architect knows its members to be classicists, he knows as well as he knows anything that, if he sends in anything but a classical design, he will have his trouble for his pains. He might, if he has a strongly-marked individuality, work out a thoroughly practical design in some other style, but he wants that building, and bends his mind to an uncongenial task, and then wonders why he did not get the prize. Thus the architectural professor retains his grip upon current architecture, though its methods and necessities may be quite foreign to his style of thought and art. Both the Professorial Juryman and the Professorial Professional Program-Producer are legitimate products of the competition system; yet both are fundamentally opposed to the true progress of architecture. To a very large extent they are a neglected element in current architecture, but they are getting in their innings with the wisdom of the proverbial early bird. A true appreciation of their real nature must help to destroy much of the present false confidence in the unquestioned merits of competitions, as it will likewise help to make clear their inherent unfairness. Meanwhile the Program-Producer and the Jurymen should be carefully selected in every case. They cannot, if architecture is to live, be permitted to become a class.

ABOMINABLE as architectural competitions necessarily are, some good words may be spoken for the bill passed by the late congress permitting limited competitions for public buildings. If there has been one phase of American architecture more atrocious than another, it surely has been its official side. Americans do not naturally do foolish things, but they clearly exceeded all previous records when they evolved an architectural system whereby a single office, and nominally a single architect, should be responsible for the huge number of government buildings yearly erected in this country,—a number now estimated at about 300. And in order to make things as bad as possible,—as if this in itself were not sufficiently preposterous, —all of this was to be done by an architect holding office for not more than four years, and often for less, and, as likely as not, as incompetent to undertake work on this gigantic scale as he was to earn the meager salary of the post by private practice. It is no wonder that the architects of this country have been protesting for years against the horrors of this situation, and it is no credit to the intelligence of our national legislators that years have been necessary to bring about a reform. The new law contains many imperfections and is not at all what it should be, but it is a move in the right direction. The secretary of the treasury is now authorized to institute a competition limited to five architects for any public building at his discretion. This is the substance of the law. It is not mandatory, it need not be applied in every instance, and only the successful architect is entitled to compensation for his plans, which are to be executed under the supervision of the supervising architect of the treasury. Insufficient as the law is, it must work many important and long needed reforms. Whether under it our official architecture will take a fresh lease of life and thrive and flourish in a way long unknown to it may be doubted. But then this art could not, by any possibility, be worse than it is, and there is every reason to believe that the present entering wedge will prepare the way for further efforts and more successful results in the near future. For severa years the chief business of the meetings o the American Institute of Architects ha been the discussion of such a law as this and the taking of measures to secure it enactment. The present legislation i largely due to the activity of that body but its occupation is not yet gone. Ther is much to be done yet for the furtherin of American official architecture, and o American architecture in general, befor the Institute can regard its chief missio as finished.

ONE of the most notable changes in current architecture is the transformatio which is taking place in the color of ou buildings. It was only a few years ago tha our chief cities were characterized by dullness of color scarcely supportable; no they fairly blaze in a multitude of shade which is the more remarkable since it ha always been considered that polychromati architecture is quite impossible in th rainy, damp, changeable climate in whic the people of the seaboard American citie see fit to live and thrive. We have by n means obtained a polychromatic archite ture, as it is understood under the brillia skies of southern Europe, but our citie are exhibiting a diversity of color, and variety of tint that is positively delightf after our interminable red bricks a brown stones. Much of this variety caused by the yellow brick which has b come so fashionable of late, the use which is growing, if anything, a little to promiscuous. But it affords a gratef change and enables the architect to obta results quite impossible with the older a more common red. Red, as a city colo is rapidly moving from the walls to t roofs, red tiles being now as much in fav for a roof covering as red bricks were on for walls. That the possibilities of red a not yet exhausted—rather that they a not yet understood—is evident from t gorgeous coat of red paint that has r cently been applied to an iron building the old type that directly overlooks t City Hall Park in New York. Such a dee rich color was never seen on a building b fore, and the effect of a six-story stru

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ure painted in this ravishing shade from op to bottom, only relieved by a few adertising signs uniformly painted in plain gold, is positively startling. From an rdinary unattractive structure this buildng has become one of the most conspicuous in New York, and it is well worth a rip to lower Broadway to see it. It offers possibilities in the coloring of buildings hitherto undreamed of, and it would not be surprising if the success of this transormation should popularize the horrible old-style iron structure that no one has known what to do with. Chicago has its Golden Doorway, but New York has its Red Building, and for startlingness of ffect the latter city has nothing to be ashamed of.

IT is difficult to understand why Professor N. S. Shaler should work the readers of the *North American Review* up to a horrifying fear of the dangers high buildngs run from earthquakes, only to assure them, in his conclusion, that the danger is not very great or likely to do any of us harm. There is absolutely no limit to the what-may-happens, and the possibilities of earthquakes on the Atlantic coast are not too remote to render it foolish to take them into account. Any sort of catastrophe may happen in a great city, and a heavy shock of earthquake would unquestionably do a vast deal of damage not only among high buildings but among low ones. The human mind, however, is not given to estimating at their real value remote probabilities. One need not trump up an earthquake to find danger to human life and limb in many an apparently well-built and outwardly good building, which may be known to be unsafe, but which no one hesitates to enter. And then when one finds, after all, that the likelihood of an appalling catastrophe from earthquake is very small, one cannot but wonder why a stir should have been made about it. It is to be regretted that Professor Shaler, in composing his terrifying paper, should not have consulted an architect or an engineer. Had he done so, he would have escaped making several errors of his own and would have made a much more valuable contribution to high-building literature than he has done. Thus he speaks of buildings intended to last through centuries. Costly as our high buildings are, it is not to be supposed they are intended to last for that length of time. Their duration may naturally be longer than that of the low buildings they replace, but it is not at all improbable that new conditions of life and business will arise which will render their present form quite unsuited to a more advanced state. It is surprising, also, that so keen an observer as Professor Shaler should refer to the present limited use of steel in building. One need only look over any great city and see the gigantic steel skeletons rising from every street to realize how large a part this material takes in current building methods. And this omission on the Professor's part is the more to be regretted since he looks upon the increased use of steel in building as an additional safeguard against earthquakes.

Mr. BERG'S book on buildings and structures of American railroads* is a notable production in many ways. Not only is it the first considerable book of its kind on the subject, but it is thoroughly complete, dealing in the most detailed manner, and with the amplest illustrations and examples, with all sorts and kinds of railroad structures, from watchmen's shanties to the terminal railroad stations of great cities. It is this which gives the book its real value and which will make it, for many years to come, the best authority on the subject. The larger part of the work is devoted to what may, for want of a better term, be called the mechanical part of railroad building, to the study of the structures used in the actual workings of a railroad, and which, though often devoid of architectural treatment, are, from the railroad man's standpoint, more important than the costly depots and stations of large cities. Much of this material is, of course, without architectural interest, but it is a very necessary part of railroad architecture, and Mr. Berg follows it through the smallest detail in the most conscientious manner. The examples given are numerous and selected from all the railroads in the country, so that the reader has here, in convenient form, representative types of the best railroad construction. Aiming as he does to represent chiefly railroad construction, the author does not undertake to illustrate the architectural possibilities of these buildings. Yet in glancing over his pages one may obtain a very fair notion of the architectural status of railroad buildings in this country. As a whole it is not satisfactory. Many of the smaller buildings, those of wood and in which cheapness is naturally the first consideration, actually lose by attempts at decoration. Probably no class of wooden structures have been so neglected in this country as railroad stations and similar buildings, though many changes for the better have been introduced in the stone and brick buildings now generally erected. The architect, in fact, has little opportunity to display his ability in such buildings, and it is only in the more considerable edifices that railroad architecture attempts to become artistic. Mr. Berg's book is a monument of painstaking labor, and may be most cordially commended to all directly concerned with the topics of which it treats, while the general student of architecture may learn much of interest and of value from it. It is so thoroughly good that the author will pardon our regret that the names of his sketches, of which there are seven hundred, were not placed underneath them. The designation "perspective," "ground-plan," etc., is in every case intelligible without a printed legend to that effect. The name of the building illustrated in the perspective or plan, as the case might be, would have been of assistance to the reader.

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* *Buildings and Structures of American Railroads.* A Reference Book for Railroad Managers, Superintendents, Master Mechanics, Engineers, Architects, and Students. By Walter G. Berg, C. E. New York: John Wiley & Son, 1893.

LAST month we had occasion to refer to the fiftieth anniversary of our venerabl London contemporary, *The Builder*. W have now to extend our congratulations t a much younger contemporary, and th time an American, *The Inland Architec* of Chicago, which has just celebrated i tenth anniversary. This lively, wide-awak and admirably edited periodical is one c the few indispensable periodicals to th American architect, supposing, of cours that he is sufficiently interested in affai to wish to keep abreast of architectur progress in the west. It is a clean, whol some paper, breathing the ceaseless activit of the west in every line, and reflecting th most admirable features of its architectur thought. It is a pleasure not only to b familiar with its text and its plates, but to b able to congratulate it on reaching the er of its first decade. Not the least of th merits of *The Inland Architect* is the su port and encouragement it gives to wes ern architects to write for its pages. W have more than once had occasion, in th place, to refer to the lack of the litera habit among American architects. Th reproach cannot lie at the door of o breezy western contemporary. While might, perhaps, be an exaggeration to s that one of its missions is the formation a school of literary architectural writers the west, it has, by making copious use the literary products of western architec gone as far as an independent journ could go that was not wholly committ to such a policy. Its readers may, ther fore, always count on some fresh, interes ing, and valuable contributions, which, w its judicious and thoughtful editorials, ma it one of the very best papers of its kind this country. If it has a fault, it is that only comes to hand once a month inste of once a week. We extend it hearty co gratulations on reaching the present peri in its career, and trust we may be able renew our felicitations at many subseque such occasions.

INDUSTRIAL CHEMISTRY.

Conducted by Dr. R. A. Witthaus.

THE hygiene of building materials is a study but little known in this country, although in Europe it has attracted considerable attention. Dr. Serafini, assistant at the Institute for Experimental Hygiene in Rome, has recently published the results of a series of experiments on this subject, an account of which may be found in a recent number of *Good Health*.

The porosity of various materials was determined as follows: Small pieces were dried at a temperature above 100° and then placed in hot distilled water in such a manner as to drive out completely the air contained within the pores. When the mass was saturated, the surface was dried with bibulous paper and the exact volume determined according to the principle of Archimedes. The surface was then again dried and the mass weighed, after which it was thoroughly dessicated by heating to above the boiling-point of water, and a second weight taken. The difference in weight indicates the amount of water absorbed by the pores, and the relative volume of water to that of the whole mass was thus obtained. Figures expressing the total volume of the pores as compared with the volume of the mass were as follows: Lime rock, 44.62; red brick made by machinery, 32.79; red brick made by hand, 36.77; mortar from an old wall, 33.88; travertine, 4.44; and marble, 0.25.

The permeability to air was also determined, and a table is given. It was found that one square meter of a brick wall two feet thick, one-fifth of which was composed of mortar, transmitted in one hour's time, with a pressure equal to that of a water column of two inches, 600 liters of air, or about twenty-two cubic feet. It has been falsely assumed that, owing to the porosity of ordinary building material, artificial ventilation is of small consequence. The ridiculousness of this position is at once apparent when we compute that an atmospheric pressure equivalent to a water column two inches high is only produced by wind traveling at the rate of forty-five miles per hour, while the pressure of a light breeze is 500 times less than that required in the above experiment to produce twenty-two cubic feet an hour. It will be remembered that not less than 2000 cubic feet of air per hour are required for each person. The amount of air passing through a wall in a given time is diminished by increased thickness, but not in direct proportion. A five-fold increase in the thickness of a wall diminished the air transmitted only one-half, while increasing the thickness of a wall twenty-five fold only reduced the volume of air to one-fourth. A third series of experiments was conducted by Dr. Serafini to determine the best conducting property of different materials, and a table of the results are given, cork being taken as unity.

A more interesting study was that of the relation of the various materials to microbes. Lime and mortar, it was found, never contain microbes, and when the latter were incorporated with the former in laboratory experiments, they soon disappeared. Old walls, however, contain microbes even to their centers, as was demonstrated by Dr. Sanfelice in regard to the walls of the hospital San Gallicano. It was shown by the experiments that the microbes of the air pass through building materials only with great difficulty, but when suspended in water they readily find their way into the interior of the mass. In one case germs were found to have penetrated four inches into a brick after it had been in contact with the culture for six weeks. The *bacillus prodigiosus* penetrated a block of limestone to a depth of four inches in five weeks, without pressure, and to more than half that depth in the space of two weeks. The ready penetration of limestone, brick, and similar material by germs renders important the adoption of means to prevent the saturation of walls from contaminated soils. The author draws the conclusion from his various experiments that the lateral walls of buildings should be made impermeable to air, not only to prevent the penetration of the walls by microbes, but to allow for frequent washing without saturating the walls by moisture.

PASSING on to a material of construction treated from another point of view, we have the admirable papers on Portland cement and Portland cement concrete by Mr. Bamber, Mr. Carey, and Mr. W. Smith presented to the British Institution of Civil Engineers. It is pointed out in the paper by Mr. Bamber that the usual method of determining the completeness of burning, namely, by weight per bushel, is fallacious, and that the specific gravity is a better guide. He states that a good new cement should have a specific gravity of 3.1 to 3.15, and that, if it fall below 2.9, the cement has either been improperly burned or has afterwards deteriorated by exposure. In the taking of the specific gravity, he advises water rather than turpentine, which is generally used, on account of the sensitiveness of the latter to the temperature. The practice of aërating cement is deprecated. Interesting experiments upon the proper proportion of water to use in mixing concrete are described. Blocks composed of four parts of shingle, two of sand, and one of cement were used, and several sets more made in duplicate with varying proportions of water. The first were mixed with as much water as the cement would take up, or about 10 pounds for each block; the second with 7½ pounds of water; and the third with 5 pounds. After standing for a fortnight one of these sets was placed on a sea-wall for twelve months, where it was exposed to tide action, and the other was similarly exposed to the action of fresh water. Upon examination at the end of the period named it was found that the one with 10 pounds of water was hard, sound, and dry throughout; the one with 7½ pounds of water was dry at the center, but had been penetrated to a depth of three inches; while the one with 5 pounds of water was wet through, much of the lime had been removed by the sea-water, and the block was weak. Other experiments proved that, with the decrease in the amount of water used, the bulk, and consequently the porosity, was increased. The author concludes that it is necessary, in order to secure sound concrete, to have it thoroughly wet, that it may be non-porous and impermeable to the action of the water when placed in position.

In the paper by Mr. Cary, on "The Inspection of Portland Cement for Public Works," is shown the fallacy of the once universal requirement that not more than 10 per cent. of the cement should be left on a sieve with 2500 meshes per square inch. In reality it is only the floury cement that has any cohesive properties, and the residue left on a sieve with 32,257 meshes per square inch has practically no cementitious value. The effect of fine grinding is thus shown: A standard sample was prepared, giving, with 9 per cent. of residue on a sieve of 2500 meshes, a tensile strength of 220 pounds per square inch. With the residue above removed 304 pounds per square inch were obtained, while with the residue on a sieve of 32,257 mesh removed the tensile strength was 360 pounds per square inch.

In opposition to Mr. Bamber, Mr. Cary deems the aëration of cement desirable, to remove the baneful effects of free lime and, in view of the change that cemen often suffers on a long voyage, he suggests that it be exported in clinkers to be ground at its destination. Mr. Cary also insist upon the necessity of determining the specific gravity and gives as the minimum gravity of 3.1. With respect to testing h is in favor of the one-inch by one-inch briquette, and prefers hand-trowelling to the Arnold apparatus, because of the great facility in judging the quality by manipulation. Exposure to frost was found to delay the increase in strength of cement though the final strength is the same.

Mr. W. Smith, in his paper on "The Influence of Sea Water upon Portland Ce

nt, Mortar, and Concrete," shows that
ere exposed to water, and particularly
the case of sea-water, it is of greatest
portance that the concrete structure be
pervious. A series of experiments was
rformed, and the conclusions were that
) the cement must be finely ground; (2)
e cement should not be present in
naller proportion than 1 to 6 of sand and
ones; and (3) the concrete must have
fficient time to set before the application
f the pressure. Mr. Smith shows the fu-
ility of trusting to a film of calcium car-
onate for securing impermeability, and
lso criticises the use of a covering of
Portland-cement mortar from the same
purpose. He concluded that the only
ertain way is to build the entire mass im-
permeable.

WE take the following note from the *Engineering and Mining Journal:* "In this country a good deal of difficulty is experienced in testing cement because of the liability of the briquettes breaking through the head, instead of at the small cross-section. This irregular fracture can in most cases be attributed to the fact that the jaws grip the briquette along a line, instead of the surface of the jar being in contact with the briquette over a considerable surface. In Europe a different form of jaw is employed, and, according to the research of a French Government commission of engineers, there are in consequence fewer cases of irregular fracture. In the report they say that these better results are due both to the form of the briquette, which is molded with a groove in its center, and to the form of the grip, which, instead of being sharply convex and thus affording only a small surface of contact, has a large radius of curvature at the point of contact." It is of extreme importance that physical tests, often imperfect at the best, should be conducted with most scrupulous care and attention to details in order that the results may have even an approximate value. Hence it is to be advised that our American engineers should avail themselves of the hints thrown out by France in this matter of cement-testing. As a rule the American takes the lead in such matters, his native ingenuity in the adoption of "machines" removing from him all "personal equation" and the accompanying liability to fall into error. There are many instances, however, where old and imperfect methods may be found, and there is, as there always must be, room for vast improvement, especially in this line of physical testing.

IN a paper read by Mr. H. S. Poole before the Mining Society of Nova Scotia an account is given of the experience in that country with the flameless explosives "roburite" and "acadine." The former was introduced from England in 1890, but previous to that date gunpowder was the only explosive known, and owing to the fiery nature of many of the mines it had become necessary in some instances to close down. The principal experience so far has been with roburite, which has given satisfaction, though at first there were many complaints. The miners complained of missed shots, of shots that did but half the work expected of them, and of charges that did not explode. The trouble was found in the failure to follow the instructions, and in tamping the charge as they had been accustomed to tamp gunpowder. The cartridges were exposed to damp and were otherwise maltreated. Naturally they refused to do their work, but now that the new material is better understood, it is steadily growing in favor, and so far about 7300 pounds have been used. In only a few instances have flames been observed, and a possible cause in these may have been in a short circuit of naked exploding wires. The tendency in the beginning was to use too much of the roburite, but now its strength is understood to be weight for weight 2½ times greater than gunpowder, and its quantity is regulated accordingly. Among the disadvantages may be named that common to all compounds containing ammonium nitrate,—that is, of absorbing moisture on exposure to the atmosphere, being thereby first weakened and then rendered useless. The cartridges are rendered waterproof by dipping in paraffin, but as an additional caution it is well to store them in a magazine where the air is kept dry.

Acadine, a mixture of ammonium nitrate with nitroglycerin, is manufactured by the Acadia Powder Co., of Waverly, N. S. On account of the possible decomposition of such mixtures with the formation of acid and possible consequent explosion, their manufacture is prohibited in England, but no such misfortune has occurred in Nova Scotia, where, however, the precaution is taken of using the material as soon after making as is possible. Acadine has several important advantages over roburite, among which are the following: It is cheaper and requires a less expensive detonator; hard tamping does not affect the explosive power, and consequently, when a charge fails to explode on the detonation of the cap, a second primer with a fresh cap may be used. This is not so with roburite, which becomes consolidated to the extent of defying explosion. In only one case has light been observed, during an experience with 6400 pounds of the material. The strength of acadine is 50 per cent. greater than gunpowder.

IT has been a frequent practice to ventilate a cargo of coal with the view of removing the inflammable gases therefrom. That this in itself is an introduction of a source of danger is made clear by Professor Clowers, of Nottingham. From an account of his observations in the *American Gas Light Journal* we abstract the following:

Four colliers were loaded with coal from the same seam and by means of the same tips. Three were ventilated and the fourth was not; the former were consumed by fire before reaching Aden, while the latter arrived at Bombay in safety. It was evident that the ventilation of the coal had supplied just that air necessary for its combustion when heated which was absent in the case of the unventilated coal. Coal which has been heated in the air and has begun to cool again is safe from further heating; hence storing coal in the air for a sufficient time before loading is calculated to insure the safety of the cargo. The following conclusions were reached: First, the danger of spontaneous firing of coal in large lumps is very slight; it is much greater with smaller coal, and greater still with dust. The increase of danger is due to the larger extent of surface exposed to the air in proportion to the mass of the coal. Second, air-dried coal which contains more than 3 per cent. of moisture is dangerous; if it contains less, the danger diminishes. The moisture contained is a measure of the absorbent power of the coal for air, and the more absorbent the coal, the more dangerous. Third, the danger is somewhat increased by the presence of pyrites, in large quantity. Fourth, newly won coal should be shielded from the air as much as possible, to prevent the chance of rapid heating, and for the same reason it is best not to stack it in large heaps, since these retain the heat. Ventilation of the coal often adds greatly to the risk of spontaneous firing. Fifth, all external sources of heat, such as steam-pipes, boilers, and hot flues in the neighborhood of the coal, add very greatly to the risk. Spontaneous heating becomes vastly more rapid when it is assisted from without.

THE removal of sulfur from purified gas has ever been an important and difficult operation in the manufacture of illuminating gas, and there is probably no gas man in the country that has not, at one time or another, been called upon to "explain" to the consumers why it is their gas "smells so." This bad-smelling gas certainly is most offensive, but, when the manager promises the irate customer that the trouble will be remedied, he is often secretly perplexed and worried to know how to do it. In view of the importance of this subject, the paper read by Mr. Goodno before a recent meeting of the New England Association of Gas Engineers is of extreme interest. Mr. Goodno gives the public the benefit of his observations and experiments upon the removal of sulfur, and an additional value is given to the paper by the able discussion which followed.

In the fall of 1890, when using a large percentage of Glace Bay coal and purifying about 1500 cubic feet per bushel of freshly prepared home-made sponge, many complaints were received of the sulfur in the gas. The trouble was remedied by the use of lime in about equal quantities with the sponge. The lime, rapidly fouling by the formation of sulfid of lime, retained the carbon bi-sulfid of the gas. At this time a cargo of Pennsylvania coal was received, and used for some months. When the Glace Bay coal was again reached, the former trouble was expected, but did not put in appearance, the same sponge being in use as before. The improved condition was now looked for in the old sponge, which by this time carried a high percentage of free sulfur; and, as one of the few solvents of sulfur at ordinary temperatures is carbon bi-sulfid, it would be reasonable to suppose that the converse is true and that the free sulfur of the sponge had taken up the carbon bi-sulfid of the gas. For the purpose of experimenting upon the removal of the bi-sulfid an apparatus was set up for burning 8.10 cubic feet of gas per hour in the presence of ammonium gas and condensing the products of combustion by suitable cooling arrangements. The sulfur was thus obtained as ammonium sulfate. Purified gas from the holder gave at 60° temp. 11.8 grains per 100 cubic feet, while the same gas after passing at 50° temp. through old sponge heavily charged with sulfur gave only 5.4 grains per 100 cubic feet. The same gas with the same treatment except that the temp. was 60° gave 4.4 grains. These results will suffice to show the manner of experimenting and some of the results obtained. At a higher temperature the sulfur in the gas again increased, owing probably to the driving over of the carbon bi-sulfid, which is of course very volatile. The same gas as above, passed through a purifier filled with flowers of sulfur moistened with steam, gave 3.2 grains per 100 cubic feet, and in all probability this small amount consists of other compounds of sulfur than the bi-sulfid. That old oxid heavily charged with sulfur and thoroughly revivified will answer as well as fresh lime in removing the bi-sulfid seems to be theoretically true and borne out in practice, for in comparing the State inspector's reports it will be seen that upon turning on a fresh box of old sponge the gas tests lower in sulfur. Mr. Goodno suggests that an extra purifier placed after the ordinary ones and filled with the oldest available sponge carrying a high percentage of free sulfur would effect a permanent improvement in the quality of the gas and prove a safeguard against crossing the 20-grain limit. Such an additional purifier would need changing only at long intervals, and the expense would be small. A discussion followed, and many interesting points of experience were brought to light.

VARIOUS processes, electrical and other, have been suggested and tried for the disposal of sewage, or for the nullification of its poison, which is the same thing. A process invented by Mr. William Webster has been tried in England, and that of M. Hermite has been in operation for some years at Rouen, with highly promising results. The method in vogue at this latter place—namely, the electrolysis of the sewage direct after the addition of common salt or chlorid of iron—would hardly be practicable in a city like Paris with its enormous output of sewage daily, but a modification could be used and the electrolyzed solution added to the sewage. This application of electrolytic disinfection becomes especially possible wherever sea-water is at hand, as for instance on shipboard or at the seacoast towns, so often starting points of infectious diseases.

MINING AND METALLURGY.

Conducted by Albert Williams, Jr.

MISREPRESENTATION in a prospectus sometimes subjects the company fathering it to certain after inconveniences, at least in English law. Not that a serious result is certain to follow; but it may. Indeed, if there were any certitude or even probability that false or exaggerated statements in a prospectus would react upon the utterers, the extraordinary literature of the incipient English mining corporations would have been considerably abridged. However, a case has recently come up in the English courts, the decision in which may rather astonish most readers, for the offence was by no means of an especially heinous order, but one which seems trivial in the light of what has been published officially by mining corporations there and elsewhere. In the case referred to, the plaintiff had applied for and had been allotted a certain number of shares in a new company, on which he had paid certain sums, and he petitioned to have the register of shareholders rectified by having his name removed, and to have the money so paid refunded to him. The ground of the application was that the prospectus contained misrepresentations, the particular one proved, and upon which the judge held that the applicant was entitled to the relief asked for, being a statement that the "promoter" would provide the preliminary expenses of floating the company, whereas in fact in the contract between him and the company it was stipulated that such expenses should be repaid him, which they were. Plaintiff claimed that what induced him to invest was the apparent good faith shown by the "promoter."

Another case which came up before the same court shows, however, that a shareholder, if he has ground for complaint as to matters contained in the prospectus which induces him to subscribe for shares, must not let the grass grow under his feet. In this case the plaintiff awaited the issue of a suit by another shareholder, and after the latter had been successful he delayed a month longer before taking action. The court held this delay to be unreasonable and the right to relief forfeited.

Commenting upon these two cases, "A Barrister," writing in the London *Mining Journal*, gravely warns directors of new companies that it will be well "to see that the statements contained in their prospectuses are accurately phrased," and advises them, "if they have any doubt as to the meaning likely to be placed by an intending subscriber for shares on any particular sentence," to consult their lawyer—and hedge.

The innocence of the British investor and the peculiar methods of the British "promoter" are subjects of constant wonderment in the United States, but so far as crookedness goes it's the old story of the mote and the beam. At this very time wildcat mining shares are being floated upon American small investors on the strength of prospectuses and reports which under the first ruling just cited would, in the English courts, and under similar circumstances, entitle the victims to recover the amount of their investments. A little more law of that kind would have a salutary effect everywhere. If it did not deter those who are pecuniarily irresponsible from pushing fraudulent schemes, it might at least cause sponsors of new companies to be cautious in putting forth reckless and over-colored statements about the properties whose shares are offered to the public.

BASIC steel is reported as making decided progress abroad as a material fo engineering construction, such as bridges In Germany and France it is even bein specified as the material to be used in suc work, and *Iron* [London] states that i the former country experiments are being carried out to prove that it is equally, if not better, adapted for constructive purposes and even for shipbuilding than Bessemer or open-hearth steel. It is further reported that in France the process is so successful that basic metal can now be produced cheaper than manufactured iron, and promises to take the leading position there. In England large orders have been placed recently for basic steel in plates, bars, channels, and angles for bridges and similar work, though the output is still behind that of Germany. In the United States there are special reasons why the growth of the basic process has been checked, but the production promises to be considerably increased by the operations of a new company in the South. The prejudice against the metal seems to be disappearing, and the process promises to do much toward developing the large deposits of phosphatic ores, otherwise unavailable.

AT a recent meeting of a foreign engineering society, in the course of a discussion of papers upon lead-smelting for the precious metals, one of the speakers expressed a doubt whether in American practice over 92 per cent. was saved of the contents of the ores treated. Such a statement of course argues total ignorance of the subject. It is a sufficient refutation to say that the custom smelters, in buying ores, pay on the basis of 95 per cent. of their tenor in silver and lead; while for gold, if the ore contains over one-twentieth of an ounce per ton, they pay for the total contents. They pay for silver and lead the full rates established by the New York quotations of the day, and for gold either $19 or $20 an ounce. The smelters have to stand transportation expenses on the crude lead bullion to the refinery or market, usually at a long distance, also cost of refining, commissions, etc. Further, the smelters pay cash for ores on receipt, but as the lots bought may be carried for stock in the bins or in the ore beds for some time, they lose the interest on the value of their purchases, often for many months. The system of buying ores is complicated by the varying smelting charge, discrimination against silica, zinc, or other undesirable elements, and allowance for iron and other fluxing constituents. But the fact that the basis of the business is as just explained shows that the percentages saved in smelting must be high. Competition in the ore market has rendered close figuring a necessity, but the smelters certainly do not conduct operations at a loss. Whether there is a profit or a loss on a particular lot of ore bought cannot always be told. The kinds and proportions of the ores in stock influence the selection of new material. Each lot loses its identity in the smelting mixture, so that what its individual results may be is not known. In the long run the system pursued is undeniably profitable, though precise calculations are difficult even to the managers, owing to the complexity of the business. It is estimated that about 10 per cent. of the lead, carrying a less proportion of silver, passes out of the stock as fume and flue dust. Of this over one-half is ultimately recovered in the annual clean-up. One of the great smelting-works has more than a mile of flues and dust chambers, and a main chimney 350 feet high. With a plant like this the losses in fume and dust are brought very low, while modern methods keep down the loss in slags, besides which there is a partial retreatment of the slag shells. As to the gold, the smelters invariably overrun the assay figures; that is, they get out apparently more gold than is charged into the furnaces as ore. This is because all silver and lead ores carry traces of gold, which, if too small to appear in the assay reports, still count up in the aggregate when concentrated in the bullion and refined, while much of the flux carries other small quantities, and also because, as stated, the smelters do not pay for less than one-twentieth of an ounce (say $1) per ton. The loss of gold from volatilization is slight. What passes into the flues and dust chambers is mostly carried off mechanically with the other matters. If exceedingly refined assays were made of the most minute quantities of the precious metals entering into the furnace charge, and if there were an absolute clean-up of everything, the campaign would be found to give a better showing than a recovery of 95 per cent. on each of the three metals, silver, lead and gold, in the regular practice at our largest custom smelting-works. The managers know pretty closely what they are doing, but not quite. The public naturally knows less.

IT is sometimes argued that the invention of the safety-lamp has done more harm than good. It has reduced the number of colliery explosions; but on the other hand it must be admitted that explosions, when they do occur, are of far greater gravity than they might have been had no safety-lamps been in use. This is readily understood when it is remembered that the safety-lamp encourages working in gaseous mines which, without it, would have had to be abandoned, and that confidence in it begets carelessness, which sooner or later by some trifling accident brings about disaster. Collieries are also worked on a much larger scale than at the beginning of the century; the workings are vastly more extensive, and the number of men exposed in any given instance has been correspondingly increased. Yet it would be taking a very short-sighted view of the conditions to condemn the lamp on that account. M. Le Chatelier, whose admirable work has been previously quoted in these pages, rightly says on this head that it is sufficient, in order to prove the value of the invention, to compare the number of deaths caused by fire-damp with the quantity of coal extracted, which has increased with marked rapidity,—tenfold indeed,—while, happily, accidents have by no means increased in the same proportion. The truth is that the safety-lamp is only one factor of safety, and must not be counted on to do more than should fairly be expected of it. So far as its own proper function extends, it is a great help; but it is not everything. It is not possible to prevent the emission of fire-damp or to neutralize it; nor can dangerous accumulations be always guarded against; nor is there any certainty that causes of ignition can be wholly suppressed. In short, as M. Le Chatelier concludes, it must, as a rule, be acknowledged that it is quite impossible to entirely do away with any of the above-mentioned causes of accident, and we must be content to reduce their frequency to a minimum. He adds: "Moreover, the simultaneous attenuation of the different causes permits of obtaining a degree of security in itself considerable, almost absolute; it is, in fact, the case that, if each of the causes of accident occurs by itself with tolerable rarity, the probability of their simultaneous occurrence, which is indispensable for bringing about an accident, will become infinitely minute." This he illustrates by supposing the frequency of fire-damp accumulations "equivalent to that during one whole day out of a thousand working days; and also supposing the frequency of causes of ignition to be equivalent to the use of naked lights during one whole day out of a thousand working days. Then the probability of simultaneous occurence of accumulations and exposure to ignition will be as 1 : 1,000,000,—that is to say, an accident would occur on an average once in every three thousand years, which may be regarded as practically absolute security. If, on the other hand, account be taken only of the causes of ignition, without diminishing the causes of accumulation,—that is to say, if regular working be carried on in fire-damp (as has been too long the practice in collieries), it will no longer be every 3000 years that an accident will happen, but every three years." Which would mean that the colliery would have to be abandoned. M. Le Chatelier's assumed figures are fictitious, but they bring out the case very clearly. The evident moral is—*ventilation*, with every secondary precaution besides.

IT is believed that the production of platinum is closely regulated by the demand and the price. In 1891 the output from the placers in the Urals was 136,220 ounces of crude platinum, about 80 per cent. fine. This was valued at about $5 per ounce, crude. The production in 1891 increased 30 per cent. on that of the preceding year, being stimulated by the marked advance in price, which had ached $16 per ounce for the pure metal. ince then the price, which had been ar- ficially upheld, has declined to its normal ate of $8 or $9 per ounce, though the onsumption of the metal for the leading ires of incandescent lamps is on the in- rease, while its use for crucibles and other hemical apparatus and for jewelry re- nains the same. The small quantity (500 o 600 ounces) of crude platinum sand nnually obtained in connection with gold placer mining in the United States would doubtless be increased if more attention were given the matter, while some new Canadian localities promise well. A small supply comes also from Brazil and from the Cordilleras of South America.

IMPORTANT deposits of bauxite have been discovered in Saline and Pulaski counties, Arkansas. This mineral is used in the manufacture of aluminum, as a refractory material, and in making alum and aluminate of soda. Professor J. C. Branner, State geologist, reports that the beds vary from a few feet to over 40 feet in thickness. Its identity and value were not recognized until lately in Arkansas, where it had been prospected as an iron ore, and used for building roads, without suspicion of its real nature. As Professor Branner says, bauxite is not a common mineral in any part of the world, and as it has a spongy earthy appearance, and is very light, there is nothing about it to attract the attention, and this is probably the reason it has been so long over-looked. The French bauxite mines are the principal source of this mineral. In the United States it appears to be of rare occurrence, so far as known, though there is a bed of it in Georgia.

GRADUATES from the technical schools at first find themselves rather at a loss when brought to face the great number of samples to be assayed daily in a large smelting or other metallurgical establishment. At the school laboratories there is always plenty of time, but little room; and the methods taught there are right in principle, but dilatory. In practical work things are different, and both methods and apparatus may seem strange to the novice. Here the assayer has to keep up with the regular routine of the establishment,—so many samples to dispose of daily, so many in a batch, and the reports to be turned in at stated hours, with occasional extra pressure in emergencies. If he runs behind and is overweighted by the rush of business, he is likely to get rattled and make breaks. After a while, however, he picks up wrinkles which enable him to get through the regular tale with more comfort. At every large works short cuts and special appliances have been adopted or invented to meet the peculiar exigencies and handle great numbers of assays rapidly without detracting from such precision as may be necessary. Some are pretty generally known in the profession, others are almost private property, though not kept so for the same reason as trade secrets. All these things are not taught in the schools or described in the text-books. Every young assayer has to be coached by his more experienced associates, or find out for himself. Another thing he has to learn, not often inculcated in his preliminary training, is to discriminate between matters requiring minute exactness and those which can be treated more roughly, and to divide his effort accordingly. There is a great deal of floating unpublished knowledge about assaying which the professors and the text-book writers seem to be unconscious of. It is a pity, for it places the student at a disadvantage in the outset. If every assayer who has originated or learned new time-saving or labor-saving devices that are proved to work well in practice would make them known through the technical press or the transactions of the societies, eventually the schools and the books might get hold of them, and there would be less lost motion.

INVESTORS in gold- and silver-mining property have a weakness for taking up too much territory,—*i. e.*, more than can be well handled under one management. One claim of full size, 1500 feet long, is large enough to contain a big mine; and two continuous claims give as much ground as can be advantageously worked from a single shaft sunk near their junction. One mine at a time is enough, and is worth any number of undeveloped prospects. It is also better policy to concentrate effort on the most promising ground, and not dissipate it by scratching about tentatively. Yet Eastern and foreign companies usually buy a whole group of locations, and in their prospectuses and reports make a parade of owning so many distinct "mines." There is, however, a very good reason why, in many situations, the owners of a valuable mine should wish to acquire title to all the adjacent claims; and that is for mere protection against the uncertainties of litigation under our dubious mining laws. Conflicts over titles are always to be expected where a property is worth anything. To guard against them a certain extravagance in purchasing territory is warranted, and may be considered prudent. But this is something apart from mining policy proper.

ACCORDING to the *Colliery Guardian*, English coal-miners work on the average only about 40 hours per week, the range being from 32.87 to 44.9 in different districts. This estimate is surprisingly low, lower in fact than those for any other European coal-mining country, or for the United States, where in the leading districts the weekly range is from 48 to 52 hours. In the principal German coal-fields the average per week is 48 hours; in the Belgian collieries, 54 to 56; and in the principal French coal-fields, 50. When the British labor commission was in session last year, considerable antagonism to an eight-hour law was evinced by many of the coal-miners, who considered that, if such a limit were imposed, it would involve, if not as an express enactment, at any rate as an implied corollary, that they should not work less than eight hours daily. As in all similar cases, it seems to be impossible to fix by legislation any time limit which shall be satisfactory to all—still less to bring the several elements of length of working day, wages, occupation for the greatest number of men, output, consumption and price of product, into consistent harmony and reconcile them for the best of all concerned, by any artificial restrictions. The natural adjustment is the safest, and practically it always prevails in the long run.

COMPOUND or bi-metallic plates of steel and copper are being made in Germany as a material for various utensils. Sheet steel is used, having a coating of sheet copper either on the inside or on both sides.

A PLANT for the retreatment of copper tailings by the sulphuric-acid leaching process is to be established by the Arizona Copper Co., at Clifton, A. T., to work over the tailings from its concentrating mill. This process of extracting copper has been for a long time successfully employed, though on a small scale, at the Lyon mill, at Dayton, Nev., where the bluestone (copper sulphate) produced found a local market in the amalgamating mills of the Comstock lode.

BY means of electric welding it is now possible to produce forged steel projectiles rapidly and economically. A hollow steel bloom is cast and rolled out to a thick-walled tube of the approximate size of the finished shell. This is cut into suitable lengths, and the head and base, formed in dies, are then welded on. Very little machinery is necessary. A high-carbon steel head can be welded to a cheaper lower-grade material. These electric-welded shells are being made by the American Projectile Co., at Lynn, Mass.

THE cause of unusually rapid rusting of some rail-bedplates has been attributed to a high percentage of silica and sulphur in the original iron, from investigations recently made upon material supplied to the Austrian railways.

THE total production of pig iron in 1892 was 9,157,000 gross tons, against 8,279,870 tons in 1891, and 9,202,703 tons in 1890. The production in 1892 was only 45,703 tons less than in 1890, in which year our maximum production was attained. The production in the first half of 1892 was much larger than the last half.

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THE CHOLERA PROSPECT IN 1893.

By D. B. St. John Roosa, M. D., LL. D.,

President New York Academy of Medicine.

THE most recent advices are that cholera is still raging in Russia, and that it exists in a slight degree in Hamburg and in some parts of France. The probabilities are, unless travel and immigration from Russia are immediately and strenuously interdicted, and unless the water-supply of Hamburg is made absolutely pure, that cholera will reappear in an epidemic form in Germany and France this spring and summer. But these two contingencies are within human control. Travelers and immigrants may be prevented from entering Germany, and purity of the water of Hamburg may be secured. While cholera has not been epidemic in any European port during the past winter, "sporadic" or isolated cases have occurred constantly in some of them. There are some persons—I will not say authorities—who assert that true Asiatic cholera exists in Paris during the entire year. Certainly it was there last summer. Assuming these statements to be facts, we have good reason to fear that this disease will reappear in New York harbor during the summer of 1893. But it is quite possible for the city of New York and the other parts of this country to be so protected, and for those coming here with the disease to be so isolated, as to prevent an epidemic in the United States.

Cholera is a much more simple disease to manage than the grip, for example, chiefly because we know more about its causes. Though we have now passed through a three-years' visitation by the latter-named disease, we are not any wiser as to its cause, and have no more means for its prevention, than when it re-attacked us

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in 1889. It is a malady which no human skill can avert. So far as we know, no special care, no formulated rules, will prevent the lofty and the lowly alike from being its victims; and even if the patient survive the attack of the disease, serious chronic affections which in some way or other prevent the patient from perfect recovery to health may result from it. Of cholera we know much more. We know its origin; we know that it is caused by a morbid germ (bacillus), propagated by water, milk, and foods of all kinds, which multiplies infinitely, but which is not often carried from one person to another, unless it actually enters the body. It is not usually sufficient to breathe the infected air of choleraic patients to become affected. I say "not usually sufficient" for the reason that cases have been said to occur in nurses who have been obliged to remove the excreta of patients, and in patients debilitated by other diseases, who have been kept in hospital wards with those suffering from cholera. But even in these instances it is probable that the bacillus was actually taken into the stomach. It remains true that those who are absolutely punctilious about food and drink that may carry the germ, generally escape the disease, however many may fall around them. But a bacillus from dried secretions, or on infected clothing, may become dissolved and enter the mouth, through the medium of the air, just as in the case of typhoid fever, which is also a disease not contagious from person to person, unless the typhoid germ enters the body. Again, it is not certain that every one thus having the germ in the body will be attacked with the disease; probably there must be a soil ready for it. In many instances good habits of life are a most effective guard against this fatal disease. It is indeed fatal, for at nearly the beginning of the twentieth century, having known of the cholera for a thousand years, we have perhaps no more means of combating it successfully, if it has once seized upon the human system, than we had when it first became known to civilization. It can hardly be said that the treatment in Hamburg in 1892 was any more successful than that in New York in 1832, when it first appeared on this side of the Atlantic.

The medical profession have generally accepted the belief that the bacillus discovered by Koch, in 1884, is the cause of cholera for the following reasons: *

I. It is almost always found in the stage of the disease known as collapse.

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* Professor W. Gilman Thompson, "Pepper's Text-Book of Medicine."

II. When the disease does not exist, the bacillus is not found, and, with its disappearance it disappears.

III. The bacillus is found in the evacuations from the bowels, and in the smaller tubes of the great intestinal canal. It is just this region that is particularly affected by the disease.

IV. When the lower animals are inoculated with this bacillus, symptoms similar to those of Asiatic cholera are produced, and collapse and death occur.

The cholera bacillus, as described by Koch, looks like a comma, and can easily be picked out from all other products by an expert microscopist. This germ multiplies very rapidly in the intestinal canal. It can, however, be easily destroyed immediately after evacuation, here again following the parallel with the typhoid-fever germ.

If an epidemic of cholera occurs in America this year, it is impossible to say in advance what kind of a visitation it will be. It cannot be said that we had an epidemic during the last year. There were a few cases, perhaps a dozen, in New York city. Some medical writers profess to be able to draw the line between true Asiatic cholera and the severe cases of cholera morbus that are always with us, and they insist that, without Koch's bacillus, there can be no true cholera. This is probably true, though not yet absolutely proved. Yet, if the bacillus is not found in every case, it is no proof that the disease is not true Asiatic cholera, for the bacillus is a short-lived one in the human body. The lines of demarcation between diseases are not arbitrary, like geographical lines, but are dependent on a great many conditions, so that one disease may pass into another almost imperceptibly. The human body is so dependent upon the common supply of nourishment through the blood that bone and muscle and connective tissue are taken care of by the same nutrients, and invaded by the same disease, having, it is true, different characteristics, according to the part invaded. Small-pox is an entirely different disease from diphtheria, but cholera is not entirely different from the so-called cholera morbus—*cholera nostras*—that we have constantly in this country.

The characteristics of cholera may be briefly outlined.* It is a constitutional affection; that is to say, the whole organism suffers. The derivation of the word indicates that it was supposed to be an intestinal flux, for the etymology shows that it means a flow of bile. The disease suddenly develops, being marked by great uneasiness of the general system, followed by copious discharges from the bowels, and fainting. The attack may overtake the victim while he is walking on the street, in apparently good health. Sometimes it is preceded by a period of vague uneasiness, very rapid prostration, deep-seated colicky pains, loss of appetite, sweating, with more or less slowness of pulse, when the disease is always fully developed. The symptoms follow each other in such a manner as to be divided into two periods. In the first period the movement from the bowels and the vomiting are frequent, almost continuous, and the discharges are those characteristic of cholera, fluid and whitish, sometimes resembling a decoction of rice or oatmeal, sometimes thickened meal, very rarely giving traces of blood or bile. Usually there is also great thirst, pain in the stomach and prolonged hiccoughing, great cramps in the calves of the legs, the skin becomes blue and black, the nails livid, the fingers wrinkled. The whole body seems to be shrunken and shriveled, the eyes sunken and dull. The secretions of the body are arrested, the voice becomes a whisper, the nose is cold, the intellect obscured, the breathing difficult, and death follows in the midst of what is apparently a calm. When the patients escape death, they enter upon the second period, when the warmth returns to the body, the pulse improves, the face regains its color, vomiting is less frequent, and the diarrhea and discharges are no longer peculiar. The average duration of cholera is from one to three days, though sometimes death occurs in less than six hours. This is, of course, entirely unusual. When an epidemic is beginning, if the so-called *cholerine* cramps do not occur, the other symptoms are present, but in a milder form. Cholerine generally ends in recovery, and some authorities even deny the existence of such a disease.

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* Harold C. Ernst, "Reference Hand Book of the Medical Sciences."

As to the prevention of cholera, much has been said for and against strenuous maritime quarantine. The more ignorant the nation, the more intense and annoying the quarantine, whether maritime or on the land frontier. During the epidemic of 1885 in Italy and the south of France the Italians outdid themselves in ridiculous and inefficient and obnoxious rules to prevent perfectly well people from going from one country to the other. England perhaps lays less stress upon maritime quarantine than any other nation, but England is not a depot for immigration, and filthy immigrants from all parts of the world do not come to her shores as they do to those of the United States. Those who visit England come only as actual travelers or immigrants *in transitu*. If the Russian immigrants who, having passed a few days in Hamburg, without any cleansing and other sanitary means, were put upon ships which they infected had been allowed free access to New York city last summer and autumn, they certainly would in a few days have so polluted water-sources that cholera would have become epidemic. We must, therefore, have quarantine regulations in this country. But, if a ship comes to New York harbor, even during the visitation of cholera, from a non-infected port, and has passed seven days without the occurrence of any case, it would be folly to retain the passengers on the ship. They should be allowed to land as soon as the facts about their condition are ascertained. If cholera has actually broken out upon a ship, the healthy passengers should certainly not be retained upon it, when the port is reached. They should be put on shore in comfortable quarters, and after a very short quarantine, if the disease does not break out among them, they should be released. If quarantine must be practised, it must be a civilized and humane quarantine, instead of imitating the Turks and Italians.

The authorities of cities should see to it that absolute cleanliness in the streets, courts, outhouses, stables, and public buildings is maintained. This should be the case the year round, whether cholera exists or not. But it is difficult to show the harm to public health from dirt. It is usually not observed by the people or by the authorities, and it is impossible to induce them to maintain the highest order of cleanliness unless something like an epidemic of cholera, or yellow fever, is threatened. New Orleans, under the military rule of General Butler, and Memphis, and Naples and Marseilles, after an epidemic had taught the authorities the necessity for absolute cleanliness, are striking examples of what sanitary engineering will accomplish for the public health. In the cities of Naples and Marseilles great sanitary works were undertaken which it will take years to complete. It is not an easy thing to learn what cleanliness is. An untrained man, however philanthropic, and however much of a statesman he may be, does not necessarily know when a city is clean, or how to clean it. The medical profession itself is just learning what is necessary to keep wounds clean, and to maintain cleanliness in the persons of surgeons and in their patients. The task of keeping inhabited centers, sources of water-supply, and means of travel free from the effects of the daily and hourly pollution of human employments and human functions is one demanding expert knowledge, such as exists only in two professions—those of medicine and engineering. Yet one of the laws of the State of New York prevents a physician from being president of the board of health of the metropolis of the country. It is even very difficult to impress upon individuals the necessity for personal hygiene, in order to avoid disease. Many illnesses that are thought to be special visitations from Providence occur only because of the neglect of personal care. The time will probably come, however, when the human race will everywhere, with only exceptional instances, live out its life. It is perfectly possible to conceive of the domination of human intellect and human force being so universal as to abolish accidental death.

When an epidemic is threatened, the public are willing to practise virtues which they ignore when the pestilence is not stalking at noon-day. It may be well then for those in public positions to enjoin proper rules of life upon those dependent upon them. During an epidemic of any kind each individual should endeavor, as indeed he should under any circumstances, to maintain his mental equilibrium,—in other words, to keep cool. It is very difficult in our time to accomplish this, for the simple reason that some of the daily journals think it their duty to print sensational head-lines, and sometimes sensational paragraphs, which have very little actual foundation, but which excite and terrify the timid, and sometimes even the brave-hearted. The writer was once in a foreign country where an epidemic of cholera was prevalent. He never knew how violent it was until he received the newspapers from his own country describing it. Such an effect did they have upon his friends that he was written to by several of them, urging him to fly at once, when, as a matter of fact, he was in no more danger than he would have been in his own dwelling at home. The cholera only prevailed among the vicious, intemperate, and ignorant classes, who violated the most ordinary rules of personal cleanliness, and yet the news sent from the same places intimated that every individual even in places entirely free from cholera was likely soon to be attacked and swept off the earth. I am not in favor of governmental censorship of the press, but I am very earnest in my hope that the press in our country will be moderate and judicial in statement should cholera ever become epidemic among us. I think that it can be properly urged upon the citizens of New York and adjacent cities, should the cholera appear, that they refrain from reading about it, unless they are sanitary or medical experts, wishing to learn all they possibly can as to the progress of the epidemic, and are able to look upon it in a scientific and cold-blooded way. The public should drink none of the ordinary water-supply of the region in which cholera prevails, no matter whether it is certainly contaminated or not. No water ought to be drunk unless it has been boiled, or unless it be the water from some locality known to be absolutely free from the possibility of infection. In the second place, uncooked vegetables and uncooked fruits should not be eaten. It was a great trial to the people of Paris, when the cholera raged in the south of France in 1885, to give up their delicious melons, but it was a very wise precaution, because the medical experts have shown us that the germs of the disease are likely to lie and germinate upon uncooked vegetables and fruit, and thus be propagated, to a greater extent than in perhaps any other way, except through water or milk.

Those who employ a large number of men in factories, mills, or on routes of transportation ought to secure the simple directions from the board of health, and cause them to be printed, publicly posted, and circulated among the families of the employés, and all through trains should have a physician and hospital supplies on board. A great field will be opened to the sanitary engineers of the world in protecting water-supplies, and in general work to prevent pollution from the soil. It is to be hoped that this will also be done in New York, although I can see no evidence as yet that the public authorities appreciate fully the necessity of medical and sanitary experts in the prevention of epidemics. One of the latest signs of the failure of legislative bodies and public authorities to appreciate in the United States what has been done in other countries by sanitary engineering is the crude method adopted to free the Croton watershed from pollution. Land contiguous to the water-supply has been purchased, or seized to be afterwards purchased, and public officials have gone on the soil and removed and burned property of various kinds, apparently without any definite plan of preventing the pollution, which may result from the presence of a few tramps, the day after the houses and stables and outhouses have been destroyed by fire. If the government is to purchase all the land adjacent to the water-supply of all the cities and towns, we shall soon have a debt beyond even the financial capacity of our country. We are the only people, so far as I am informed, that have ever sought this means of relief from the neglect of sanitary laws. Without buying a foot of land, it is possible, under a proper sanitary police, the supply having first been treated by experts, who have prepared a system of protection, to maintain purity in the water of all the great cities and towns. We are just in the dawn of knowledge on this point. Civilians having forgotten the war of 1812, when "the West Point Academy might be said to have decided next to the navy the result of the war,"* had to learn at great cost during the late civil war that invading countries and defending them are matters of scientific study, the art of which must be learned from experts. West Point proved to be of more value than the farm and country home in training leaders of armies. So in the great questions involved in the approach of epidemics, protection can only be had by following the advice of expert authority.

As has been said already, cholera is a disease that can be more effectually guarded against than many which do not cause as much alarm. If the quarantine regulations are honestly maintained, with skill and scientific knowledge, there need be no extension of the disease from our harbor. Perhaps it will not even be brought there. The effect upon the World's Columbian Exposition by the appearance of the cholera in New York would, in the nature of things, be extremely bad. Europeans, having read much of the scenes in our harbor last year, would be afraid of their repetition, even if they did not fear the disease itself. The precautions taken by the general government are, however, so careful and faithful, in the placing of medical officers of our own at every port of departure, that it is hardly to be feared that any such numbers of infected ships can possibly arrive in New York as came from Hamburg last year. Public instruction should be given by the government, at the beginning of an epidemic, or even in anticipation of an epidemic. This is being done already, to some extent, in New York city, where lectures by physicians are being given to the poorer classes as to what to do in order to avoid cholera. If they could be supplemented by practical instruction—object-lessons as to the danger of neglected garbage, drains, and traps; if the ordinary plumbers could also be taken in hand, and proper police regulations enforced, in all these respects—even if the cholera did appear here, it would not acquire a firm or lasting hold. It is always to be remembered that cholera is an exotic in America, and indeed in all Europe. It is really a part of the soil only in India, though perhaps it is becoming a natural disease in Russia. Being thus able to locate its point of origin, we can restrain its virulence.

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* Henry Adams's "History of the United States,—Monroe's Administration."

Dried evacuations upon bed-clothing retain their poisonous properties for an indefinite period of time; hence the need of the greatest care that the materials which have been used by choleraic patients should be either absolutely destroyed, or rendered free from any source of contamination. While dirt and dampness will not of themselves produce cholera, without the presence of the specific germ, both dirt and dampness furnish the means for the infinite increase of the specific bacillus. Once allow the cholera germs to infect the water-supply of a city, and, that water be generally partaken of, the city is doomed. But that the disease is not contagious in the sense of being carried from one person to another, by personal contact, ought to be a source of great satisfaction and congratulation to all who may be exposed to an epidemic.

Let us hope that the present anxiety about the appearance of cholera in the United States will lead to a general recognition of the fact that expert knowledge of the two professions of medicine and engineering are the only safe means to which the public may look for a protection which is more efficacious against cholera than anything as yet known to arrest epidemics of grip, diphtheria, and scarlet fever. It has hitherto been supposed that the germs of cholera, in India, could never be exterminated, but Dr. Telyafus, of Tiflis in Russia,* seems to think that the disease could be strangled in the place of its birth. This is the delta of the Ganges, a low-lying space of about 7500 square miles. The soil here is very moist, and contains the remains of many forms of vegetable and animal life in a state of decay. Cholera has raged here for hundreds, and perhaps for thousands, of years, and after very severe rains, or from other causes not well understood, it passes out from this delta into the neighboring countries, and thus over the entire world. The present epidemic of cholera in Europe is the fifth invasion recorded by history. Dr. Telyafus thinks, because the plague was stamped out of the Nile delta, that similar measures might purify that of the Ganges. He advises cremation of the dead in India, instead of throwing the bodies into the river, as well as the planting of extensive eucalyptus groves, as has been done in Algiers. Sanitary engineering and the planting of these trees have reclaimed large and hitherto uninhabitable marshes in Algiers, so that they are now cultivated and inhabited by a healthy population.

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* *Medical Record*, April 8, 1893.

ETHICS OF ARCHITECTURAL COMPETITIONS.

By John M. Carrère.

A BILL was passed lately by the senate and house of representatives, and signed by the president, authorizing the secretary of the treasury to hereafter obtain designs for United States government buildings by competition among the architects of the country at large, and there is no doubt among those interested in such matters that this is a great step in advance.

The position of supervising architect, created at a time when our public buildings were less numerous, and scattered over a relatively small area, has become merely clerical in its functions, owing to the increased number of these buildings, amounting to as many as three hundred at one time, involving an expenditure of over $20,000,000 per annum, and spreading over the entire United States. It stands to reason that the designing of such a number of buildings, and the proper execution of them, had to be delegated to assistants. How pernicious the whole scheme, which was never satisfactory, has become is clearly demonstrated by the results obtained. As stated, therefore, the step is one in advance, because it changes the entire system, and distributes the work among the architects at large; and we may expect hereafter, under favorable circumstances, as good results for government work as for private work.

In view of the great influence that this decision will have upon architecture in this country, the question is whether the manner in which government work will be distributed is the best,—namely, by competition; and if it is, how the competition should be conducted so as to obtain the best possible results.

Architectural competitions, in the judgment of most architects, are a snare and a delusion. The principle of bringing men into rivalry in the solution of the same problem with the hope of producing the best possible work seems to be a correct one, but, even disregarding all other practical reasons, it fails to produce the desired results, because in the manner of presenting the solution—namely, by drawings—it is impossible, no matter how fully the drawings illustrate the idea, to give a complete conception of the work as it will appear. This would be true, even if the judges who select this work were always as able as those who are competing; and there is no doubt that in architecture, as in all other liberal arts and professions, the best results are generally obtained by selecting a man on his record, selecting him for what he has actually accomplished, and intrusting the work to him without competition.

A competition may result in bringing out hidden talent, and give new men opportunities which they would not otherwise secure, but the older men who have their legitimate work to attend to, which cannot be neglected, cannot be drawn into competitions for the mere sake of a chance to increase their practice, perhaps at the risk of unfair treatment, of prejudiced decisions, and of unreasonable demands upon their time; so that it is very seldom that the best men will consent to enter into competitions, and the object of the same is thereby immediately defeated.

The system of paid competitions, which has been lately adopted (where a limited number of men are selected, and offered a nominal sum to present drawings, it being sometimes understood that all other architects can send in drawings without such remuneration), also fails to meet with the approval of the leading architects, for it is really a *gamble*, a *speculation*, and therefore the system does not fully overcome the difficulty.

It is natural, as long as architects are expected to furnish for $500 virtually preliminary drawings for work entailing very often an expenditure of $1,000,000 for which it is agreed the world over that architects shall charge 1 per cent. or $10,000, that the *best* men, the *busy* men, will not consent to compete, though the layman is only too anxious to have a competition on these terms.

If competitions are ever to be a success, they should in the first place, in the writer's opinion, be made such as to commend themselves to the attention of the *entire profession*. The men with established reputations will not look upon competitions favorably, and will not take part in them regularly, until a regular schedule has been established, making uniform charges for competition drawings, in the same manner as for other professional services. Such a schedule, with all allowance for the privilege offered to compete, will place the architect's services on a business basis,—which is the only possible one. It will reduce the number of competitions and of the competitors,—confining them to the most important buildings,—and elevate the standard of the work. These will be the only terms upon which the leading men will *always* be willing to enter competitions for buildings other than public buildings.

In the matter of public buildings it is somewhat different, from the fact that the character of the building is one which not only promises renown and honor, resulting from possible success, but which gives the true architect the only opportunity for studying and designing monumental art; and for the sake of *this opportunity*, if the competition is properly conducted, the leading architects in this country would probably consent to compete.

Now, with the above conditions established, what is at present the object of a competition, and what should the object of a competition be?

The object of a competition at present seems to be a scramble for ideas. As stated to the writer by a committee-man in a paid competition for a large building: "We have ten competitors,—we can only select one architect,—but we expect to get at least $500 worth of '*ideas*' out of each one of the others."

In such competitions the result at the best is one of mere chance, depending on ingenuity of arrangement, on the scheme, and on everything in fact but architectural merit. A competition should not be the *selection of a plan*, but the selection of *an architect*. Selected not for his ingenuity, but for his composition and his skill; not for his scheme, which should be the program, and which should be furnished to him to develop, but for the ability with which he has accomplished this development.

To obtain this result, it is necessary, in the first place, that the program should be as complete as possible, giving the architect all the information obtainable concerning the requirements of the building, the different spaces, their sizes, how to be occupied, in what relation to each other they are to be used, and in important buildings, such as a city hall, for instance, a short and concise history of the manner in which the government is conducted, the functions of the different officials, their relation to the community and to each other; as much, in fact, as will enable the architect to fully understand the purpose of his building and the spirit in which it should be designed.

All of these matters are not such as the architect should be left to find out; they should be given to him, and should be based on actual experience in such matters: this applies to all buildings, commercial as well as government buildings. Why should an architect, for instance, determine the most advantageous arrangement of an office building, when these conditions vary for every city, and for different parts of the same city,—really for every new building,—and are best decided by the client in consultation with real estate men, and other experts, whose business it is to study such problems from their financial and purely utilitarian standpoint.

After the competing architects have had time to study the problem and to become familiar with the same, it would be wise for the committee and its experts to hold several meetings,—which all the competitors would attend,—for the purpose of discussing the program and its requirements, and altering it if necessary, by mutual consent of a majority of architects, with the approval of a majority of the committee. The competing architects are then fully prepared to study the problem with full knowledge of the same, and they can then depart from the program as much as they dare risk, or as in their judgment would improve the same, and their duty becomes one of composition, of architecture.

Every other possible element of chance should be eliminated from the competition. Any special features, such as a dome, a tower, the location of any particular feature, the general disposition of the building on the ground, or what is known as the block plan, even the style of architecture, if such a thing is admissible where it is to form an element in the decision, should be plainly stated. The question is not whether this or that man will think of having a dome, *but who is the man that can design the best dome; and this same principle applies to every part of the building.*

As is now usual, the number of drawings should be distinctly stated, and none others allowed. The scale of the drawings should be uniform for all of the competitors, but as the drawings are technical, and of no value except as such, they should *always* be rendered technically, from an architect's standpoint. No perspectives should be required, in which the good drawing by a clever artist, employed to assist in rendering the same, may deceive a whole committee as to the merits of a composition.

The drawings should be plans, sections, and elevations, all rendered so as to establish distinctly the composition and the proportions, and made of such a character as to absolutely require to be passed upon by experts. For purposes of comparison the manner of rendering should also be determined. The number of drawings should *always* be as few as possible,—only as many as necessary to place the composition fully before the jury,—and their scale should be as small as practicable, and all drudgery and drawing should be reduced as much as possible, so as to enable the architect to devote

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his entire time to the study of proportion and composition, and not to the rendering of elaborate drawings. The busy men have not the time, the younger men have not the means, to enter into such elaborations. One full-size detail, or a large scale drawing, or both, of some prominent part of the building, drawn by the competitor himself, should be asked, to establish the ability of the architect to execute what he has composed, and this will prove of a good deal more value than the usual perspectives,— and if a perspective is found necessary, for a committee for instance, it should be merely technical in its presentation, almost a *block perspective.*

Every other possible safeguard, both as to avoiding any chance hit on the one hand, and any possible unfairness on the other, should be resorted to. No communications should take place between competitors and committee, except in writing, and such communications and the replies should be furnished to every competitor. If the competition is a public one, all communications should be published in the newspapers.

The employment of the successful architect in accordance with the terms approved and adopted by the American Institute of Architects should be guaranteed, his competition drawings being considered as the equivalent of preliminary drawings. All other competitors should be guaranteed that their plans will be returned to them and will remain their property, and that they will not be used in part or in whole, excepting by proper compensation, the value of which will be established by the jury.

In public competitions prizes should be distributed,—the manner, number, and amount being adjusted to suit the nature and importance of the competitions.

If the competition is a public one, the drawings should be sent without signature or mark ; they should be simply numbered consecutively, as received, the envelope with the author's name being numbered likewise ; so that no one, not even the author of the design, knows his number. Every possible chance for " wire-pulling " or undue influence should be guarded against, unless the competition is to become a mere farce. If the competition is a limited one, every drawing should be *signed by its author.*

After the jury have passed upon the drawings and reached a decision, the drawings should be exhibited before this decision is made official, to permit a full discusion of their merits,—either by the public or by those interested,—and avoid a possible blunder, which, once made, in most cases is not easily remedied.

The jury should then meet again, and revise their decision if necessary, otherwise confirm it, and the drawings should be exhibited again after the decision is made official; for such competitions would become educational for the public, but principally so for the profession. The exhibition before the decision might be limited to professional men,—and under these circumstances it would be interesting, and perhaps prove a great success, to have a discussion of the plans, and a vote upon the same, prior to the final decision.

Concerning the manner in which the architect should be selected, there is absolutely no doubt in the mind of any one who has studied such matters that the jury should be composed of men any one of whom could build such a monument himself,—not *construct* it, but *compose* it, *plan* it, and *build* it. It should consist of architects only.

The building, if well planned and well composed, will calculate and construct itself. The better the plan and the composition, the easier it will be to execute it, and no one but an architect can compose architecture. Do not select any man, therefore, to pass judgment for any other reason than what he has actually done.

If competitions can be conducted with the understanding that it is the *architect* that is wanted, the duty of the jury will consist in classifying the competitors according to merit. This jury should be engaged from the very beginning; should consist of not less than three men, to avoid possible personal prejudices; should prepare the program, assisted by the committee and with the advice of experts and specialists; and should conduct the competition in consultation with the building committee, working together throughout. They should discuss the merits of the drawings and of the architects, with the committee, and obtain fully their views, but at this point the committee should retire, and leave it entirely to the jury to decide the competition.

Such a jury would only be willing to serve in special cases, without compensation; and as only the best men can be selected, they would have to be well compensated; but if a competition is worth having at all, such matters should not enter into consideration, and if they do enter into consideration, there is no reason for a competition.

In conclusion, the writer would state that, *unless the purpose of a competition is the selection of an architect*, in his judgment it would always be better not to have a competition, but to give the work to one architect, *on his record;* or to have a consultation of leading architects, employed and paid to discuss the problem from the practical and utilitarian standpoint, and with the assistance of experts and specialists, the client or committee, and such other persons as have had actual experience with the problem at hand, decide on the best solution, and establish the scheme; the architect being engaged beforehand and taking part in the discussion, or a competition being established on the lines of this discussion, the scheme of which would then form the program for the selection of an architect.

Many of the competitions which have taken place lately have suggested many very excellent features, have created a better feeling among the profession, and unconsciously contributed to the raising of the standard of work. It is really to Professor William R. Ware, of Columbia College, more than to any one person, that we owe the firm establishment in practice, and the general recognition by the public, of the general principles expressed in the Boston committee's report of 1876, of which he was a member, and which was the first comprehensive report on this subject in this country.

COTTON AS A FACTOR IN PROGRESS.*

By *D. A. Tompkins.*

THE development of the production of cotton in the United States within a single century from insignificant proportions to 9,000,000 bales a year, considered in all its relations to our industrial progress, is without a parallel in history. First of all, it is a sufficient answer to the charge so often made against the southern part of the United States that the people are without enterprise or mechanical ingenuity. It may not be going too far to assert that everything the northern part of the Union has accomplished, put together, has not affected the welfare of so many people in the world, or reached so far in its effects, as what has been done in the cotton industry in the South. It may be answered: "The South alone is adapted to the production of cotton; if it would only grow in the North, a different showing might have been made by that section." But cotton grows in India, in Egypt, in China, and in South America, and a people cannot be without enterprise who, in competition with such a wide-

THE COTTON PLANT.

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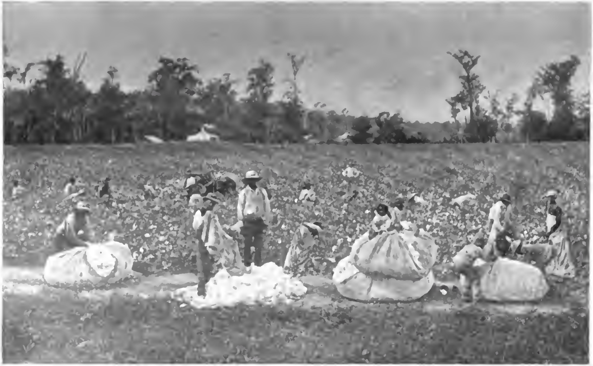
spread cotton area,—in many parts of which the plant has been cultivated for centuries upon centuries,—in less than one hundred years are able to show a production far exceeding that of all the rest of the world.

In 1820 the cotton crop of the United States amounted to about 400,000 bales; in 1892 the yield reached nearly 9,000,000 bales. During the greater part of the interval the price has been about ten to twelve cents per pound, but it has been as low as five cents, and as high as twenty-seven cents, leaving out of account the years of the war (1860 to 1864), when the South practically stopped producing cotton. Estimating 500 pounds to the bale, and the price at ten cents per pound, the crop of 1820 would have been worth, in round numbers, $20,000,000. On the same basis the crop of 1892 would have a value of $450,000,000. This great increase in production has been made in a section to which there has been no such constant tide of immigration as has been experienced by other parts of the United States, and for this reason alone the result reflects great credit upon the people who have accomplished it.

ORDINARY COTTON-PICKING SCENE.

This great achievement is the result of three things combined, namely: (1) the enterprise and energy of the people; (2) the invention of the cotton-gin; and (3) the designing of buildings and mechanical appliances by which the gin may be economically operated.



COTTON-PICKING—JAMES S. RICHARDSON'S "GLENCOE" PLANTATION, BOLIVAR COUNTY, MISSISSIPPI.

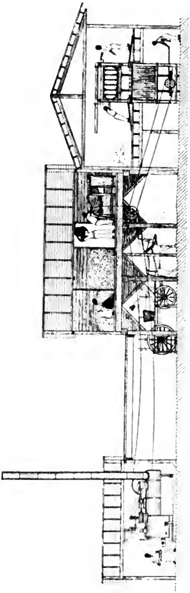
OLD PLANTATION GIN AND SCREW IN OPERATION.

It appears to be commonly believed that the successful production of large cotton crops in the United States is due to the invention of the gin alone. While this has been an essential element in the problem, yet Egypt, India, and South America, which have the advantage of perfected gins, due to the inventions made in America, produce cotton neither so cheaply nor in such quantities as in the United States. I am far from wishing to take from Mr. Eli Whitney any of the credit that attaches to his name for the invention of the cotton-gin. He stands in my estimation at the head of the list of all those whose inventions have been of benefit to mankind. In the invention of the cotton-gin there is glory enough to immortalize Whitney's name with plenty to spare for the credit of others who did valuable and essential work in the development of what he produced.

When Mr. Whitney first visited Savannah, much had already been accomplished in the way of creating conditions for the more economical production of cotton. A commission had been appointed by the State of Georgia, charged with the duty of causing a machine to be devised for the separation of the lint of the cotton from the seed. Mr. Josiah Watkins had in operation a crude machine similar in many respects to the more nearly perfect gin which Whitney constructed. The substitution of the saw for wire spikes seems to have been first been made by Col. O. A. Bull, of La Grange, Georgia, and a little later, but independently, by Hogden Holmes, of Fairfield county, South Carolina, and it was this improvement, more than any other one thing, that put the cotton-gin in shape to become such an important factor in the development of the cotton interest.

While the times were ripe for the invention of the cotton-gin, and many persons were working at the problem, and while the gin would probably have been invented even had Whitney never gone to the South, he was just the right man to quickly take up the suggestion of the Georgia State commission. He saw the Watkins

MECHANISM OF OLD COTTON-GIN HORSE POWER.

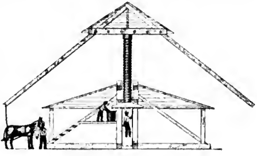


OLD PLANTATION GIN-HOUSE, WITH STEAM-POWER AND POWER-PRESS ADDED SINCE THE WAR.

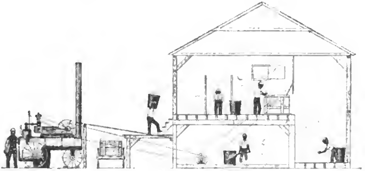
machine, worked on the problem himself, heard of Holmes's improvement and went to see it, and to his own ideas and work he added the best of what he gathered from various other workers on the same problem. The result was the Whitney gin.

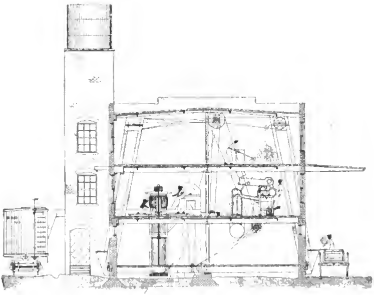
A machine having been invented that would separate the lint from the seed, there was at once a need for a proper house in which to operate it, and some power to drive it. Mule-power was the most available, and wood was the most suitable material both for the building and the machinery for utilizing the power. Therefore a series of wooden wheels, gears, and levers were devised by some one whose name is now lost. The house was built on posts in such a way that the machinery could be operated by mules under it. Considering the limited facilities at hand, this running-gear for a gin-house for the utilization of mule-power exhibits marked mechanical ingenuity and adaptability, the lack of which in other countries prevents such results in the production of cotton as have been attained here.

When the gin, the gin-house with its appliances, and the baling-screw had all been developed to a condition of practical success, the production of cotton became at once very profitable. The desire to embark in the business made a demand for labor and increased the price of slaves. The slaves of the Northern States were purchased, and still more were needed, which demand was partly filled by a trade with Africa itself, the ships of England and New England entering briskly into the business.


OLD PLANTATION COTTON-SCREW.

Slavery existed in New England about one hundred years before it was tolerated in the South. Up to the time when the appliances just described gave such a stimulus to cotton-planting, general manufactures had prospered more in the South than in any other part of the Union. Even as late as 1810, according to the United States census for that year, the manufactured products of Virginia, the Carolinas, and Georgia exceeded in variety and value those of all New England. While the production of cotton remained profitable, the growth of slavery stifled manufactures, and that interest steadily declined. Nor were any further improvements made in the appliances or methods for the preparation of cotton for the market. The standard ante-bellum gin, gin-house,

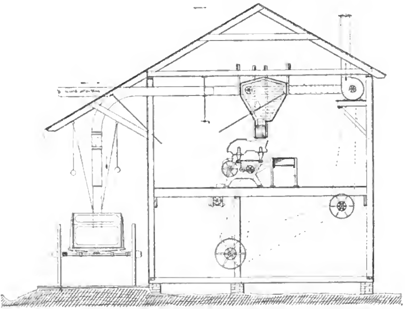

OLD PLANTATION GIN-HOUSE WITH STEAM ADDED.



SECTIONAL END ELEVATION OF MODERN GINNERY.

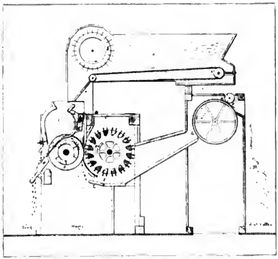
and screw were practically the same in 1860 as in 1820. Many of those of 1860 were larger and finer than those built a quarter-century earlier, but there was scarcely a new idea in the design. The inheritor of slaves had become an aristocrat, and the cunning of his forefather in mechanical art had been lost. But while lost temporarily, it must have lived in the bones of the people, because no sooner had the late war ended, wiping slavery out of existence, than one improvement after another began rapidly to appear. Before the war mule-power, slave-labor, and wooden machinery were universally used for the preparation of cotton for market. Every plantation had its gin and gin-house, and, barring only the separation of the lint from the seed and packing, all the operations in handling cotton were performed by man power. The cotton was packed by hand, carried into the gin-house in baskets by laborers, carried to the gin by laborers, fed to the gin by laborers, pushed into the lint-room, carried to the screw, packed in the box of the screw and bound with ropes, all by hand. Slave-labor was abundant and cost so little that there was no incentive to improvement.

Subsequent to the war a feeder was invented for the gin, to save the labor of hand feeding. Then came a condenser, to save



SECTIONAL END OF A MODERN GINNERY.

labor in the lint-room, then a hand-press that could be operated in the lint-room of the gin-house, to save carrying the cotton to the screw, then a power-press, then cotton elevators, some using spiked belts and some the suction of air. Within thirty years the spirit of enterprise, invention, and improvement in the people of the South has not only revived, but



SECTIONAL SIDE ELEVATION OF MODERN GIN, FEEDER, AND CONDENSER.

the entire method and all the machinery and appliances for preparing cotton for the market have been revolutionized.

The cost of ginning 1500 pounds of seed cotton and of baling the lint is to-day only about one-fifth of the cost in 1870. The plantation gin-house and screw have been supplanted almost entirely by the modern ginneries, which are centrally located and are manufacturing-plants rather than plantation equipments. Many of them are incorporated as parts of plants in which the lint is separated from the seed and baled, the oil is taken from the seed, and the cake is ground into meal to be used as a fertilizer or cattle-feed, as the markets may demand.

In almost every community in the South there may now be found a manufacturing-plant known as a gin, oil-mill, and fertilizer-works. These gin cotton, crush cotton-seed for cotton-seed oil, and, buying some of the ingredients which are used with cotton-seed meal, mix commercial fertilizers. Out of this development has come the further business of fattening cattle on cotton-seed hulls and cotton-seed meal. Recently a large business has been developed by these factories in preparing a stock food made of cotton-seed hulls and meal, mixed. Before the war the seed were a waste product; ten years ago the hulls were used for fuel only. Last year cotton-seed sold at $20 per ton and the hulls at from $3 to $5 per ton.

COTTON AUCTION-SALES, M'KINNEY, TEXAS.

The most expensive item now left in the production of cotton is the cost of picking the fiber from the stalks in the field. This opportunity for the exercise of ingenuity has not been neglected during the last few years. Numerous patents have been issued for cotton-harvesters, many of which are absolutely without merit, but some of which are marvelously ingenious. One that seems, so far, to have come nearest to doing commercially successful work is that of Mr. C. T. Mason, of South Carolina. The extent of the incentive for the solution of this problem may be judged from the following estimate :

COTTON COMPRESS AT M'KINNEY, TEXAS.

The price now paid for picking cotton is from 50 to 75 cents per hundred pounds. About 1500 pounds of seed and cotton are required to make a ball of lint weighing 500 pounds. The cost of picking 1500 pounds of cotton at, say 60 cents per hundred, would be $9. Therefore to pick ten million bales, which limit it is assumed will be reached in the near future, would cost, at present prices, $90,000,000. It is claimed by the cotton-harvester inventors that a machine can be made which with one mule and one laborer can pick or gather 4000 pounds of seed cotton per day.

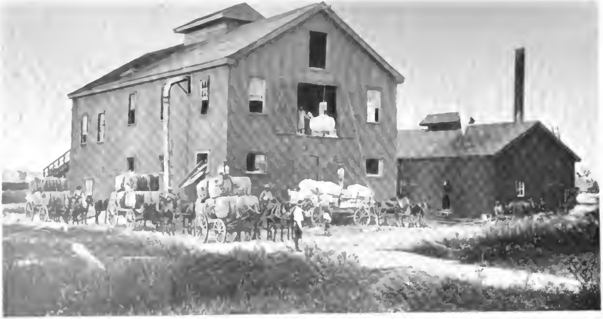
COLORED PLANTATION HANDS IN THE SOUTH.

whereas the picking of 150 to 200 pounds by hand is a good day's work.

The following table will give some idea of the increase in production of cotton every tenth year, and of the value of each crop included in the list, since 1820, expressed in round numbers. Values are all based on the rate of 10 cents per pound, and an average weight per ball of 500 pounds.

YEAR.	Production in bales.	Value at 10 cents ℔ pound.
1820	400,000	$ 20,000 000
1830	1,000,000	50,000,000
1840	1,600,000	80,000,000
1850	2,250.000	112.500,000
1860	3,600,000	180,000,000
1870	4.250.000	212,500 000
1880	6,600,000	330,000,000
1890	8.000.000	400,000,000

As has been stated already, the seed were before the war a waste product except where used in the Southeast to a limited extent as a fertilizer. Since the war the cotton-seed oil business has been developed to such an extent that in the current season about



MODERN STEAM COTTON-GINNERY.

THE VICTOR COTTON-MILL, CHARLOTTE, N. C. (BUILT 1888.)

1,500,000 tons of seed will be crushed for oil and other products. Out of these seed come the following products, against which their values are shown :

50,000,000 gallons cotton oil	@ $ 0.50	$25,000,000
700,000 tons hulls	@ 4.00	2,800,000
500,000 tons meal	@ 20.00	10,000,000
50,000,000 pounds short lint	@ .03	1,500,000
Total		$39,300,000

This much comes out of what was in the days of slavery almost entirely wasted.

It is not alone in the utilization of cotton-seed that the revived mechanical genius of the South has been exhibited, but in the manufacture of cotton into yarns and cloth as well. In a region of country reaching along the foothills of the mountains from Lynchburgh, Virginia, to Atlanta, Georgia, almost every town has one or more cotton-factories, built since the war. Many factories have been built on the water-powers in the country, and towns have grown up around them. At first only coarse goods were attempted ; then finer and finer products, by degrees. While as yet no very fine goods have been produced, enough has been done to prove that as capital accumulates and the owners acquire knowledge of the business and the operatives improve in skill, there is no more limit to the quality of the goods that may be made about Charlotte, North Carolina, than those that may be made about Lowell, Massachusetts, or Manchester, England.

The present industrial development in America, in England, and on the continent had its beginning in four events, the absence of any one of which would have destroyed the greater portion of the value of the other three. These were the invention of the power-spindle, the invention of the power-loom, the invention of the cotton-gin, and the response to these of the southern portion of the United States in the production of the raw material for the utilization of these inventions.

It is not alone of interest that the impetus given to the production of cotton by mechanical inventions has added to the productive capacity of Southern agriculture and increased the wealth of an important section of the United States. Every family in the whole country has been benefited by the cheapening of clothing and other articles made of cotton, by reason of the marvelous increase in the extent of production of this fiber. The manufacturing and commercial interests of New England have been promoted to a remarkable extent by the same cause, to say nothing of the effect upon the cotton-manufacturing interests in England and other parts of the world, and the increase in the consumption of cotton goods due to the wonderful cheapening of their cost. The single item of the benefit to the shipping interests due to the cotton-carrying trade is of great extent. Cotton, more than any other one item of freight, has been the basis of transatlantic commerce.

Leaving aside these general considerations of benefits at home and abroad, to industry and commerce, and the increased comfort of the human race, we may again recur to the importance to the

ATHERTON COTTON-MILL, CHARLOTTE, N. C. (FINISHED 1893.)

TAKING SHORT LINT FROM COTTON IN AN OIL-MILL.

Southern States of the cotton-growing industry in a great variety of directions. Cotton as a basis of wealth and of productive industry has made possible the growth of prosperous cities and towns where, at least before the development of mineral resources in the South, nothing of the kind could have existed. The cotton interest has contributed to the success of all transportation systems in the South. Even the development of mining in the South has been hastened by the need of iron by railroad companies for the transportation of the cotton and in the manufacture of cotton machinery, and the need of coal for purposes to which cotton has given rise. The cotton-growing industry, in short, has furnished what opportunity has existed in this large portion of the Union for the employment of engineering and mechanical skill, contributing thus to every branch of material progress.

THE GRAVITY SYSTEM OF RAPID TRANSIT.

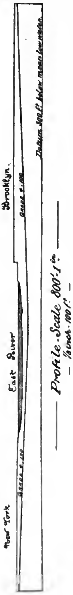
By Major Benjamin S. Henning.

IT has often been observed by experienced engineers that a great mistake was made in not raising the tracks at the stations of the New York elevated railways two or three feet above the general level, so that the trains might have the potent aid of gravity in getting a full headway of speed on a down-grade, with a like advantage in stopping on an up-grade. Such an improvement would of course be a disadvantage to fast through trains, for which a level track is best ; but the records of travel on the roads will show that 90 per cent. or more of the traffic is local. In other words, *to render the service which is required* of the elevated roads, it is necessary to provide for *stops at every station* ; and hence the idea is now prominently before the public of permitting the company to construct a third track for the accommodation of through express trains, running down at certain hours in the morning and up at certain hours in the evening.

Now, if gravity would afford such a manifest advantage in the case of the elevated roads, it clearly points the way for the application of the same principle to the whole distance between stations. In short, why not give the track a gradual incline to the center of the distance between the stations, and a corresponding ascent the remaining distance? It is a law in physics that an object dropped from any height, describing a curve, will rise to the same height, less the retardation by air and friction, as demonstrated by the principle upon which the pendulum in a clock operates, a very small spring in the mechanism of the clock serving to keep a comparatively ponderous pendulum in constant motion by giving it a slight impetus at each end of its vertical curved motion.

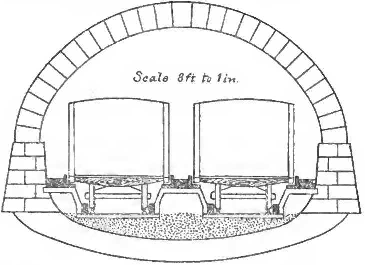
There is, in fact, now in existence a corporation designed for the construction of an underground road upon exactly this system, between the City Hall in New York and the City Hall in Brooklyn, running beneath the East river. Some of the wealthiest men in the two cities have interested themselves in the organization under advice of skilled engineers of the highest standing and application has been made for the necessary city franchise.

On the following page is shown a simple illustration of the plan, which will explain itself fully. Briefly stated, the idea is to commence in New York at the intersection of Spruce and Nassau streets, with an underground platform 16 feet below the surface of the street, to which access will be given by a broad and easy stairway, requiring an opening at the surface of about 20 by 80 feet. Commencing with a grade of about 2 per cent. for the first 360 feet, the track will then descend at a grade of about 4 per cent. to near the middle of the East river, and then ascend at a similar incline on the opposite side; thus making a tunnel with such slight grades that a horse and wagon could be driven through it without difficulty. On the Brooklyn side the station will be in the vicinity of the City Hall, and with similar conditions as on the New York side. Both the cars and the tunnel will be brilliantly lighted with incandescent electric lights, and thoroughly ventilated by air-shafts. Steam being unfit for underground railways, and neither electric nor compressed-air motors having as yet been developed to a point of efficiency for such heavy traffic, a short cable system will be employed at each end. Taking hold of the train at the start, the grip will be so constructed as to automatically release its hold so soon as gravity increases the speed of the train beyond that of the cable; and in like manner at the other end the grip will take hold at the moment the speed of the train becomes less than that of the cable.



The cars will be constructed after the excursion model, with sliding doors opening on the sides, and all operated by a crank at the end of the car; each car seating 96 passengers, or a total of 576 for a train of six cars. With a maximum speed of 52 miles an hour in the center, and an intermission of 2½ minutes between trains, the capacity per hour would be 14,400 passengers, all seated. The trains will be operated upon the block system, no train being permitted to depart till the one preceding it has arrived at the opposite station.

In the factor of safety, such a system offers important advantages. Collisions are impossible. The rails will be of the heaviest type, and, being away from the influence of the weather, will be less liable to break ; and as weight of rolling stock is rather an advantage than a detriment, wheels and axles can be heavy and strong and of the best material. In case of the breakage of wheel or axle, the car will simply settle down a few inches on rollers, running on a separate friction track just beneath the sills of the cars, as shown in the accompanying engraving. If the grip should break or fail to attach, or if either of these should happen, the car or train would simply roll back to the bottom of the incline, and passengers could walk up to the next station,—all without danger, as no other train could get on the block during the delay.



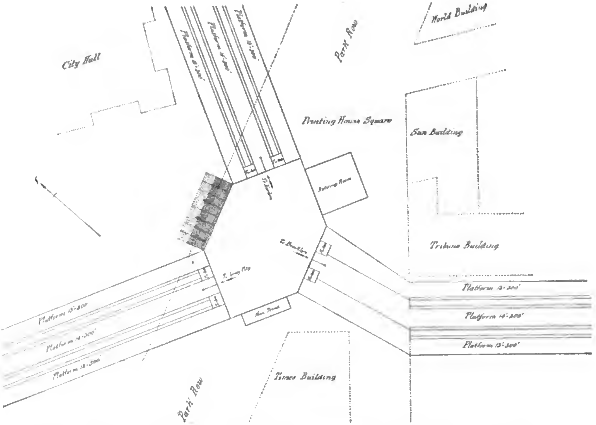
In the essential matter of cost, such a system has everything to commend it. There would be no disturbance of vested interests or property rights, and hence no outlay for costly terminals. The short cable systems at either end would involve a less expenditure than for separate engines or motors for each of the necessary number of trains. It would be a simple tunnel, the cost of which can be accurately measured by the outlay for corresponding work ; and in the aggregate *the expenditure would be less than one-third that for the Brooklyn bridge.* And as compared with that bridge the capacity would be as great or greater, while the operating expenses would be so low as to yield a relatively enormous profit on the small investment necessary. Moreover, the tunnel can be completed in two years, where it would require ten to build a bridge.

As to the theoretical objection to underground travel, that will be speedily dissipated in the mind of the man who finds that he can be carried from the City Hall in New York to the City Hall in Brooklyn *in less than half the time now required to cross the Brooklyn bridge alone.* But the details are too numerous for my space. It suffices to say it that meets the approval of such men as George S. Morrison, General William Sooysmith and other eminent engineers, one of whom has said :

> The more one considers it the more the apparent difficulties disappear and many minor advantages present themselves ; among others, I consider the factor of safety the most important, as the chance of accident will be reduced to the minimum. I should say that it would not be greater than one to twenty of the accident chance on the elevated roads, and one to fifteen of that of the Brooklyn bridge. It will have the advantage of perfect cleanliness, of being cool in summer, and warm and free from snow and ice in winter ; nor would it be disturbed by fires along the line, as is liable to occur on the elevated roads ; it will be lighted by electricity. It presents an advantage in economy of operation, the per cent. of expense to earning capacity being remarkably small. The two inclines provide for acquiring maximum speed in shortest time, and the opposite incline not only stops trains in the shortest distance, but affords a positively safe brake that makes it impossible for trains to get beyond control.

As the Brooklyn bridge has been unable to earn any considerable return on its great cost, it is hardly probable that private capital can be found to construct any more bridges, nor is it at all likely that either New York or Brooklyn will build them. Enough has been said to demonstrate that we have here an ideal system of rapid transit for handling the great crowds of people who come to New York on business, and who return to Brooklyn to their homes.

This being true, the inquiry at once presents itself : Why is not the same system applicable to all centers of population, where the requirements are similar to those here cited ? I confidently answer that it is a system which is certain to meet the requirements wherever an overhead system is inadequate, or where an underground system is demanded ; and I freely maintain that this simple and inexpensive little underground railway between Brooklyn and New York is yet destined to serve as a great object lesson to all the civilized world, as the one means for the solution of all the difficulties which surround the rapid transit problem in great centers of population. There are now a score of cities where it can be



PROPOSED UNION STATION UNDER PRINTING-HOUSE SQUARE, NEW YORK.

Station platforms only 16 feet below surface of street, and reached by wide and easy stairways. Capacity, 34,000 per hour to Harlem and Mott Haven : 25,000 to Brooklyn and Jersey City.]

applied, but let us take for example New York, where the problem in its most aggravated form is now presented.

Between the City Hall and Fourteenth street there is far more travel and greater need for quick transit than between Brooklyn and New York. In like manner there is an enormous traffic between Forty-second and Twenty-third streets and the City Hall; and an equally urgent demand for rapid transit between the upper or residence portions of Manhattan Island and the retail districts lying about Madison square. If it is practicable and profitable, alike to investors and users, to put such a road in operation between Brooklyn and New York, it is equally desirable to put in a succession of such roads the entire length of Manhattan Island.

Against such a scheme there lies the fundamental objection to an underground system, and the decided advantages which are offered by the overhead plan, giving light, sunshine, and pure air. But it must not be forgotten that people travel from necessity, not for pleasure; and in New York, more than anywhere else in the world, high value is placed upon minutes of time. The man who can travel from Fourteenth street to the City Hall in five minutes, as against ten minutes or more by the elevated or surface lines, will not hesitate long between the two. He is certain to go by that route which will take him quickest. More than this, the elevated system is now working to the full limit of its capacity, and, after every possible extension of it has been granted and is in perfect operation, it will be still overcrowded. *There is more traffic here than it can possibly handle, and every year brings an increase.* Indeed, Mr. Louis Heilprin, in a most excellent article in THE ENGINEERING MAGAZINE for July last, has demonstrated clearly that every scheme in relation to an extension of the elevated system shows a glaring deficiency in its capacity to handle the traffic which is here now and certain to follow. In a word, there is room for all the extensions of the elevated road that can be reasonably granted or desired, and, beyond that, there is the imperative need for greater capacity and a yet faster system. No one questions the ability of the elevated trains to make fast time. If permitted to do so, they could run between the Battery and Harlem, without stops, at the rate of fifty miles an hour—just as could undoubtedly have been done on the enormously expensive underground system proposed by the rapid transit commission. But this is not the point. What is demanded is not a system of fast trains between the Battery and Harlem, for there would not be traffic enough to warrant one-tenth the cost of such a system; but there is a demand for such rapid transit as will enable a passenger to start, not at the Battery, or Rector street, or Cortlandt street, or City Hall, and get off at a particular station away up town, but a means of quick transit whereby a passenger can *get on near where he happens to be and get off where he desires*, be it anywhere from Forty-second street to Harlem. The underground gravity system is the only one that can possibly render such a service, for by the assistance of gravity a maximum speed is acquired in the shortest possible time with the least expenditure of power, and the opposite incline not only stops the train in the shortest possible distance, but affords a safe brake, thus making it impossible for trains to get beyond control. And it possesses the further advantage of a deep tunnel between stations, where it can do no injury to property on the surface, while, by rising near the surface at the stations, it dispenses with the cumbersome and impracticable scheme of passenger-elevators to convey people to the deep tunnels that have been heretofore discussed.

Then as to cost. The cry of rapid transit seems to have assumed a sort of craze in New York. Each one is trying to excel his neighbor in the grandeur and magnitude of his scheme, irrespective of possible success, and at times without regard to common sense. Just look at this picture! We have the plan of the Rapid Transit Commission, calling for a probable investment of from ninety to one hundred millions of dollars; the Green bridge over the Hudson to cost from fifty to seventy-five millions; and the proposed bridges over the East river for twenty-five millions, a stupendous total of from one hundred and sixty-five to two hundred millions of dollars. And for what purpose?

Now, as compared with these figures the cost of such a system as is here proposed would be simply insignificant. Every engineer knows the cost per running foot for building a standard tunnel, and beyond this we have only the cost of cars and the small cable power-plants that would be required at each station. I do not hesitate to say that the outlay necessary for a single new bridge across the East river, of sufficient capacity to meet the requirements, would build the New York system entire, from the City Hall to Mott Haven, and with it an arm from the City Hall to Jersey City, connecting with all the suburban and Western railroads terminating there, and thus removing the necessity for the Hudson-river bridge. This would give us a grand Union station just beneath the surface of the City Hall park, as shown in the engraving, from which a man could depart for either Jersey City, Brooklyn, or up-town, and be landed at his destination with the greatest possible degree of safety and in the shortest conceivable time. Such a grand complementary underground system, supplemented by that extension of the elevated roads which every dictate of common sense demands, would, with the surface lines, give the metropolis every facility for handling, in comfort, the enormous aggregates that are now being added every year to her busy population. And a most important consideration is the fact that *this entire work could be accomplished within one to two years' time*, as can be readily demonstrated. The longest distance between any two stations would be 2112 feet. This would control the time required to build the entire work, because building could progress each way from all stations at the same time. Consequently, the greatest distance to tunnel from any one heading would be 1056 feet. Allowing for a progress of only four feet every 24 hours, and working three 8-hour shifts, it would require 264 days to complete the New York system, work going on continuously.

But would this give real rapid transit to the upper parts of the city? Let us see. It now takes about fifty minutes to make the trip on the elevated between the City Hall and Mott Haven. It should be done in about twenty-five minutes. The distance is 7⅝ miles, and the number of stops should be twenty-three altogether, making an average of three to a mile. Averaging the time for stops at fifteen seconds, we have a total of 5 minutes and 45 seconds for all stations. On an incline of 10 per cent. descending 100 feet, with supplementary cable running at the rate of 15 miles per hour, the running time between stations (1760 feet) would be about 42 seconds, making 16 minutes and 6 seconds of running time, or a total of 21 minutes and 51 seconds for the trip. The only other important factor to consider is the maximum rate of speed acquired, which should not be so fast as to be alarming, and which, on the above basis, is only 52 miles per hour at the maximum. As it would be on a perfectly straight track, built in the most substantial manner, with high rails and deep flanges to wheels, and with a system of guard supports under sills of the cars, it is evident that this is not too fast.

In considering a system of rapid transit for New York due regard should be had for the future growth of the city, and the probable extension of population. It is not that part of New York situated above the Harlem river alone that we should consider, for, if we are to have the Metropolitan city that we all expect, it must include Brooklyn and all the suburban population that now centers in Jersey City. It is obvious then that the necessities require trunk lines from the Harlem river to the City Hall and from Brooklyn and Jersey City to the City Hall. We must also take into account business centers or centers of population already fixed and determined. For New York the business center can be safely located at the Post-office, with residence centers of population in different directions ; and hence it would seem that the limit of necessity is regulated by the extent of accommodation in the vicinity of the Post-office. Under the old style of four- and five-story buildings, such as existed a few years ago, the total passenger traffic of the city was about 324,000,000, while in 1891 it was 404,000,000, an increase of 80,000,000, of which 76,000,000 was on the elevated and 4,000,000 on the surface lines. The surface lines represent the old condition of things, while the elevated lines reflect the influence of greater facilities, and the concentration of traffic at the central point. Is it not possible that the creation of business space in these tall buildings at the business center is the next great factor to convenience of transit in calculating future increase? The creation of greater business facilities by increasing the height of business buildings has already affected the volume of traffic to a considerable extent, as is shown by the increase of 70,000,000 of annual traffic on the elevated lines within five years. And the increase of central facilities has probably gone along about as fast as necessity demands. It can be reasonably estimated, therefore, that a similar increase will take place during the next five years, provided the transit facilities are made adequate to such increase.

Not counting the surface lines, which can undoubtedly take care of a greater increase than is likely to accrue to them, the question narrows itself to the ability of the elevated lines to accommodate an increase of 70,000,000 passengers within the next five years. This means nearly 200,000 per day, or 20,000 per hour for ten hours. Such imaginary conditions transport us to the regions of the impossible. The congestion recurs at only certain hours of the day, and always in the same places—down town. We must have relief at the most central point of congestion—the Post-office. Considering the insurmountable obstacles in that vicinity to surface facilities, tunneling is the cheapest conceivable means of relief, —and gravity is the only known and controllable force that can give us the high rate of speed necessary in such short distances.

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PROGRESS IN STEAM ENGINEERING.

By Robert H. Thurston, LL. D.,

Director of Sibley College, Cornell University.

I.—EVOLUTION OF TYPICAL FORMS.

THE progress of the century, of a generation, indeed, in the improvement and in the applications of the steam-engine are among the most notable of all the wonderful developments of modern times. It has been the basis upon which has been founded a very large part, if not the whole, of our present prosperity and material wealth; while the moral and intellectual advancement of the race has been hardly less a resultant of the thousand favorable conditions introduced by the employment of this mighty power. A hundred years ago James Watt was struggling to bring into a reluctant market his "newly improved and patent steam-engine." The machine had been known in crude forms for at least two thousand years, but the steam-turbine of Hero (120 B. C.), his steam-fountain, and his many other steam-apparatus, so far as we are aware, were only toys and were never given any really useful application; notwithstanding the facts that the former was a germ of the modern illustrations of that class, a more nearly ideal form of the engine than even the most perfect of modern machines, and that the steam-fountain was a prototype of all later applications of steam-machinery up to the time when Newcomen—the inventor of the modern steam-engine—produced the train of mechanism which constituted the foundation upon which Watt and Sickels and Corliss and Green and all later inventors have, for so many years, been building. For twenty centuries the steam-turbine lay concealed amid the wreck of Grecian civilization, and the steam-fountain remained but a curious plaything all through the middle ages; the highest task of either being the turning of a spit at the kitchen fire. For two centuries after Porta and Branca and De Caus (1601-1620) revived this steam-fountain, the world still profited nothing by its dormant strength. A century elapsed after Savery made his first really business-like attempt to bring it into operation as a mining pump (1669), and after Newcomen brought forward his grandest of all the whole line of improvements, before the genius and persistence of Watt and the intelligent liberality of his partner, Boulton, had fairly given the reawakened mist giant his opportunity and assigned him his task. But, from that time, the progress of improvement of the machine and the corresponding advances of the world in all that constitutes real prosperity have been rapid and as continuously accelerated as the fall of a meteorite from the heavens.

Newcomen (1705) gave us the first real steam-engine, a machine embodying the essential elements of the modern pumping engine: boiler, steam cylinder, transmission mechanism, and pump. Watt (1763) introduced the separate condenser and the whole list of minor parts of the modern engine, and showed us how to effect improvement in its economical operation by the expansion of steam. Sickels (1841) applied to the valve-gear the first successful trip-motion, and gave us a system of cut-off apparatus which permitted Watt's idea to be carried into effect to any desired extent. Zachariah Allen (1834) showed us that the attachment of the governor to determine the degree of expansion is an element of efficiency. George H. Corliss (1849) gave us a new engine, a distinct and original type, in which were embodied the idea of Watt, the system of Allen, the principle of Sickels, and a design and construction wholly his own. Green (1855) designed a machine in which all these main principles were illustrated, but in a type of valve-gear essentially different from those of all other modern machines,—the "plug-tree" form of valve-motion. Wright (1855) and many others brought out still other forms of engines, each in its way interesting and useful, until the middle of the nineteenth century saw the steam-engine practically completed, so far as its essential elements were concerned.

Even the "compound engine" was invented almost a century ago,—by Hornblower,—and was said by Watt to be simply a too precipitate introduction of his own invention of the same kind. It was gradually perfected for marine purposes by Randolph & Elder, the great Scotch firm which has come to be, to-day, the Fairfield Works, and the builders of the *Lucania* and the *Campania*, the Cunard steamers now representing the most wonderful products of the genius of man, applied to ocean navigation. The locomotive grew into form during the first quarter of the century; and the steamboat was in existence as long before the commercial success of Fulton proved to the world that it had come into permanent use.

Recent and contemporary progress has thus been in the refinement and adaptation of the machine to special purposes, rather than in the introduction of new inventions or the addition of new improvements upon the old ones. The steam-boiler has been given new forms to adapt it to new purposes and new locations, and to make it more economical of fuel; the engine has been gradually given certain special and typical forms to better adapt it to special kinds of work, and this specialization has gone on to a most remarkable extent. To-day the railroads of the country have at least three principal types of engine locomotive for heavy-freight, for fast-passenger, and for mixed traffic, while the varieties in each division are as numerous as are the kinds of work required by the roads: some hauling enormous trains at low speeds through a level country; some pulling trains up gradients of 100 to 200 feet to the mile; others hauling "express" trains four hundred miles at the rate of fifty and sixty, sometimes eighty, miles an hour, for short runs; still others, small but active, loaded up with their own water and fuel, "switching" cars and trains about the terminal yards and stations with a power and venomous alacrity which would make our grandparents look upon them as the most uncanny forms of the mist-giant. Special types are even built for use in the yards and buildings of ironworks and in the interiors of mines. Similarly, the modern marine engine takes protean forms and applies its mysterious and tremendous power to the turning of a screw, the driving of a paddle-wheel, or the operation of a water-jet; sometimes in the well-lighted engine-room of the 10,000-ton ocean "racer"; sometimes in the depths of the hold of a vessel-of-war; often on the deck of a river steamer; occasionally concealed within the narrow bounds of the submarine or surface torpedo-boat. In the less impressive field of stationary engineering it here drives the 150,000 spindles of a cotton mill; it there turns the swift armature of the dynamo; the one revolving its shaft with a deliberation and force that impress the beholder as if he were gazing upon limitless power, the other working away with a feverish haste that seems an attempt to overtake its own product, the lightnings streaming off to give light and power over miles of adjacent country.

The progress effected during the history of the modern steam-engine has been in three principal lines: (1) increase of thermodynamic efficiency, in the completeness with which the heat-energy supplied from the boiler is converted into dynamic energy by the engine; (2) decrease of thermal wastes, internal and external; (3)

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reduction of dynamic, or mechanical, wastes of the dynamic energy thus obtained; and (4) concentration of power within reduced limits of volume, weight, and cost.

Of these several methods of promoting the economy and handiness of the machine, the first has been made effective by (1) the steady increase of pressure made possible by improved constructions of boiler and (2) the increased range of expansion and of thermodynamic transformation of energy thus made practicable. The second has come of improved methods of covering the exterior of the boiler, the steam-pipe, and the engine-cylinder with non-conductors, intercepting effectually the heat which would otherwise be conducted and radiated to surrounding cooler objects, and thus wasted externally; while at the same time, internal wastes—which occur in very large amounts by the alternate abstraction of heat by the comparatively cold metal of the cylinder, when the hot steam enters, at the opening of the steam-valve, and its later rejection when with progressing expansion the steam, in turn, becomes cooler than the iron—have been lessened by better construction, permitting a smaller area of wasting surface to thus reduce economy, and by that increased speed of piston and of rotation of the engine which has been one of the most striking changes noted during this period, and also by the more effective jacketing of the engine, by superheating, and especially by "compounding." The third gain has been made by increasing the power of the engine as a function of its weight, and especially by improved workmanship and better methods of lubrication; for this dynamic waste is purely friction, the only possible source of lost work in any permanently operative machine. The fourth of these great advances, concentration of power, has come of the steady and lately rapid progress made in securing safe operation of the engine at high speeds; while some advantage has come of the simultaneous improvement in proportioning parts and in the use of stronger materials, as in the substitution of forged steel for wrought iron, in the running parts, and of steel castings and the better classes of new bronze and brass alloys for cast iron, in the frame and attached parts; and, again, through the enhanced pressures and lessened wastes of power already referred to.

All these improvements have been the result of the application to their promotion of more mechanical genius, higher skill, more careful and scientific research, more brain-power generally, than probably have ever been given, in the history of the world, to any other directly useful purpose. The steam-engine stands, to-day, as a nobler monument, a higher tribute, to the genius of man, than any other product of his many and mighty powers that the world has yet seen. It is the source and the foundation of all his material wealth and largely of his intellectual and moral wealth. It is the prime mover in every application of his inventive and constructive genius to the solution of the problems of modern civilization. It drives the machinery of mine, mill, and workshop; it transports him and his possessions across the continents and over the seas; it gives life to the whole system of transmission of all the energies, including those of the electric light and the electric railway. It makes all that he has and is a possibility, and stands, the mist-giant, a genius of more than Aladdin-like power, the maker and the guardian of modern life. Light, heat, and electricity, all the powers of nature, are but its servants and do its work and run its errands, at arm's length or miles away, in the extension of its powers to near and distant fields of labor alike.

In performing the work of modern civilization man has compelled the service of over 50,000,000 horse-power of steam-giants, equivalent to more than 75,000,000 horses of average power, for the rated horse-power of the steam-engine is to that extent in excess of the power of the animal. This is the equivalent of the steady working power of the whole population of the globe, and probably largely in excess of that amount.

In the progress which has thus marked the introduction, in a century, of more wonders into human life than had the thousands of years preceding, the engineer has pursued the directions of development already specified, and has gradually increased the working pressure at the boiler from the barely more than atmospheric weight of the time of Newcomen, the three to seven pounds of Watt, up to 100 pounds as a not unusual minimum, to 150 pounds with many locomotives and marine engines, and to 200 pounds for the latest and most radical practice; while even in the times of Stevens, Perkins, Albans, and later experimentalists, pressures were employed, in some cases, attaining 500 to 800 pounds, and, for Perkins's work, including his steam-gun, 1500 to 2000 pounds on the square inch were safely passed. Messrs A. M. Perkins & Sons, of London, sons of the American inventor, for many years have built engines, regularly, to work under pressures exceeding twenty atmospheres. Following Stevens, who first built tubular boilers,—and who first enunciated the principle (in 1804) that "to insure safety, boilers

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must be so made that their explosion will not be dangerous,"—comparatively safe forms of these boilers—"safety boilers" so called—have come into extensive use, and the makers of "shell boilers" have learned to make them as exactly suited to their work and as safe as all the arts of the modern machine-shop, reinforcing the methods of the boiler-shop, can make them; and that is sufficiently near absolute safety to make the insurance upon them a small matter. For stationary engines the "sectional" boiler is rapidly coming into general use. It has been less successful at sea; but French builders have had such boilers in use for many years, on a great variety of vessels, and with, apparently, good results. The indications are that it will not be long before a pressure of 200 pounds will be a common one wherever great economy is sought and the multiple-expansion engine is adopted to secure it. The higher the pressure, the more anxious is the engineer to insure safety against explosion and in case of explosion, and the more does the safer, but often in some respects less satisfactory, boiler come into view as the final resort. For torpedo-boat service, particularly, this change is already effected, and the revolution seems likely to extend to larger vessels, as well as in applications on shore, at an early date, notwithstanding occasional failures.

Economy was shown by Watt to be largely dependent upon the extent to which expansion can be practically employed in the steam-engine; and following his lead, and as higher pressures have made such gain possible, the cut-off mechanism has been gradually readjusted to give a ratio of expansion rising from two at the beginning of the century, to three, four, five, and eight, in non-condensing engines driven by steam of 60, 80, 100, and of 150 pounds pressure; and this has been increased to ten and fifteen with condensing compound engines, to twenty with triple-expansion, and it may be assumed that not less than twenty-five will be taken as a minimum for quadruple-expansion engines, with their boilers supplying steam at two hundred pounds and upward. A terminal pressure, in the latter classes of engine, of from six to ten pounds above a vacuum, in the most economical machines, has been commonly the limiting element for extreme expansion; while a tendency exists to gradually, but more slowly, raise the back-pressure in the condenser to meet the former, and to force the minimum limit of temperature upward, at that point, toward that due the atmospheric pressure of exhaust steam, as the boiler pressure rises. This simultaneous increase of pressure, of expansion-ratio, and of range of temperature worked through, has given but a part, however, of the noted gain, effected since the time of Watt.

The resultant thermodynamic improvement, the increased proportion of the heat supplied which is converted into dynamical or mechanical power by the engine, has been very great; but the defects of the older machine were no less in their enormous extra-thermodynamic wastes of heat and of power than in their faulty thermodynamic adjustments for utilization of energy by its conversion from the thermal to the dynamic form. The two great methods of advancing the economical value of the machine have thus been, at all times, as they must always be: first, the improvement of the thermodynamic action of the engine, increasing the proportion of heat transformed into work, and reducing correspondingly the distinctively thermodynamic wastes; secondly, the extinction more and more completely of the thermal and dynamic wastes of the machine which are consequent upon its imperfections of design and construction, and the reduction of the losses of heat by conduction and radiation and of power through friction. All improvements in the engine which have promoted its economy have come of one or the other of these two lines of progress; the latter has been the most important of the two in the past, and is not unlikely to be the most important in the immediate future. The amount of these wastes is to-day well understood, and can be easily computed for any given case; and the engineer can to-day, as never before, readily determine just to what extent and in what direction he must seek to advance. His path is charted for him with precision.

THE GOLD-FIELDS OF DUTCH GUIANA.

By A. I. Mather.

THE voyages of Sir Walter Raleigh in quest of the El Dorado which early Spanish explorers had reported to exist somewhere in South America were a failure so far as the direct object of his search was concerned. But he did find abundant evidences of vast gold-fields, which, for the greater part, remain unexplored to this day. The writers of his day, beyond doubt, located " El Dorado " in the interior of the Guianas, a country embracing what are known now as English, Dutch, and French Guiana, and a portion of northern Brazil, all laid down in old charts as " Portuguese Guyana." It is of the gold-fields of Dutch Guiana, or Surinam, that this paper will treat.

Surinam lies on the northern coast of South America, between Demerara, or British Guiana, and Cayenne, or French Guiana, Brazil forming its southern boundary. Surinam has been in the possession of the Dutch since 1667, previous to which the Spanish, Portuguese, English, and others had held desultory possession. In 1667 a Dutch fleet of three vessels, commanded by Admiral Cryssen, ascended the Surinam river to the English settlement, captured the fort, and received the capitulation of the colonists. Meanwhile England had conquered from the Dutch their colony of New Amsterdam in America (now the State of New York), and by a treaty with Holland in the same year it was agreed that each power should retain the conquests made. Surinam was ceded to Holland in perpetuity; and New Amsterdam in like manner became the property of England.

Surinam has a sea-coast of about 220 miles, flat and low, and is of alluvial formation. Approaching it from the sea, no hills or prominences are seen. The alluvial formation is continually increasing by sediment deposited by the large rivers from the interior, which have their rise among the high gold hills and run in a northwardly course into the Atlantic. The colony contains more than 58,000 square miles. The capital is Paramaribo, the principal town, and, one might say, the only one in the colony. It has some 30,000 inhabitants, or about half the entire population of the colony. Situated upon the Surinam river, about ten miles inland, it presents

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BUSH NEGROES IN DUTCH GUIANA

the appearance of a Dutch town, with its gables, tiled roofs, and open dikes. The population is composed largely of negroes, Chinese, and coolies, with a small percentage of white Dutch. A few Americans and English are also established there. Paramaribo has natural sanitary conditions. It is built upon a shell formation, with an unusually porous soil, and draining into open dikes or canals, which are run dry every tide, and filled afresh with the inflowing of high water. This accounts probably for its exceeding healthfulness, compared with other tropical ports. The reports of the government medical bureau for the ten years from 1880 to 1890 show a death-rate ranging from 2.43 to 3.80 in 100. Contagious diseases are almost unknown. Though Demerara and Cayenne are known to be unhealthy, nature seems to have done everything to make Surinam a healthful locality.

Some forty or fifty miles up-river from the coast the land begins to show a higher elevation. The luxuriant growth of tropical

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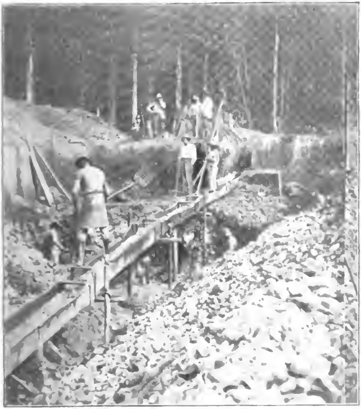
vegetation prevents a landing, except where places have been cut down and cleared for this purpose. The auriferous belt is about seventy-five miles in a straight line south from the sea-coast. It runs through the colony in a northeast and southwest direction, and also extends through Cayenne, Demerara, and Venezuela. It is from 75 to 100 miles in width, and thus far has not been half prospected. Its geological formation is highly metamorphosed, consisting of porphyry, granite, schist, and obsidian. It belongs to the Silurian period. There is an abundance of iron conglomerate, with brown and red hematite. The reddish soil shows a composition of the detritus of iron and quartz. The country is mostly one wild tangled mass of verdure. There are high mountains, which



SLUICE—UPPER SARAMACCA MINES.

LABORERS' HOUSES—UPPER SARAMACCA.

in nearly all cases are covered with heavy timber, with occasional open savannahs. Quartz is not easily found, owing to the extreme fertility of the soil, the vegetable products of which bury everything from sight, under a robe of green. Still, disintegrated quartz is freely found in creeks, and at the heads of these tributaries large pieces of quartz are found, and nuggets of gold, some surprisingly large. In the extreme dry season regular veins of quartz may be seen, crossing the rivers diagonally. No attention has been paid to quartz-mining, the alluvial washings paying well enough to satisfy all engaged. Beneath the gravel of the numerous creeks is found generally a hard yellow clay, and sometimes a bluish-white, changing downward to a soft slate. That a rich deposit of precious minerals is contained in this belt of country no one can doubt who has seen it. In the belief of more than one expert who has reported upon this subject, the Guiana district is destined to become the greatest gold-field in the world. All mining heretofore done has been of the most crude and primitive order, being confined strictly to alluvial washings, with sluices and long-toms, and mining may still be said to be in its infancy. Until quite recently no mining machinery of any sort has been used. The crude methods have been most prolific, and persons unacquainted with modern modes of mining have realized large fortunes, notwithstanding the great amount of stealings by employés. Most of the property-owners are satisfied with the products rendered, without the trouble to superintend their mines personally. Cases often occur where the laborers profit more than the employers. There is a lamentable lack of experienced miners, though a few Americans have been successful by working understandingly.

The question will naturally arise why so much mineral wealth has been allowed to remain so long comparatively unknown. This can be easily answered. The exaggerated stories of travelers, who picture this country as a death-trap, and who paint the horrors of bush-life with a master hand, are alone sufficient to deter the aver-

MANAGER'S AND OVERSEER'S HOUSES—UPPER SARAMACCA.

age explorer. Again, the mining laws permit any individual to secure unlimited territory, merely by the payment of a small tax, and to hold the same as long as the tax is paid. When gold was first discovered, large grants of land were taken, and, since all finds belong to lessees of land under the mining laws, prospectors can file no claim for rich finds. The lack of persistent application, characteristic of these people, has also tended to prevent the development of mining. So far as health is concerned, a person with a good constitution, by careful attention to diet and cleanliness, with a proper regard for hygienic conditions, will be able to live comfortably in this climate. A prolonged residence in the bush is liable to develop malaria, which is dissipated by a change to a colder climate. The days are quite hot, the thermometer registering on an average 85°. The nights are cool, however, and in the bush blankets are indispensable. There are two seasons, the rainy and the dry.

THE CANAL—SARAMACCA RIVER.

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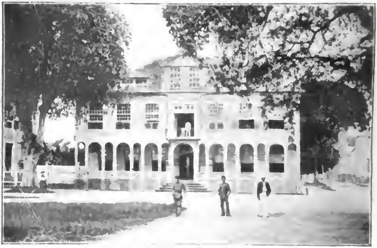
Concerning the richness of the gold deposits, I can state a few facts which have come under my personal observation. A placer containing some 35,000 acres is owned and managed by an American syndicate, who have been the first to introduce machinery for mining. They have just set up a steam dredge and amalgamator, and have a stamp-mill ready for working when quartz reef is sufficiently developed. This property, which has been worked continuously since 1879, was purchased by the syndicate in 1892. This mine has produced as high as $85,000 in one year, worked in the slipshod way peculiar to this country. At the time of sale it was paying its owner a net profit of $3000 per month, with forty laborers employed. The mining already done had been so poorly performed that second and third washings have since paid handsomely. The place may be said not to have been prospected for more than one-tenth of its area, and it will require a whole year to make a thorough prospect. In one flat, 500 to 1000 feet wide, with from 6 to 10 feet of stripping, there is a pay streak of gravel, varying in depth from 5 to 10 feet. Mining experts have conservatively estimated a pay streak over 500 feet wide, containing more than a half-million cubic yards, easily paying $5 per cubic yard. On a creek, 2000 feet of which has been worked over twice, is a high bar 1000 feet long, where six feet of stripping uncovers three feet of gravel carrying $3 per cubic yard. This bar is on the hillside. Another creek empties into a swamp with an area of nearly one-fourth of a square mile, and has a deposit of 1,500,000 cubic yards, a low estimate of which gives from 25 cents to $1 per cubic yard. One creek has at its head three feet of sharp quartz gravel, pans showing $20 per cubic yard. Another bar of gravel, some 40 feet above the creek, has 12 feet of pay dirt, 60 yards wide, pans showing $6 per cubic yard. Part of this bar has a layer or capping of ironstone some 2½ feet thick. Sixteen thousand cubic yards were estimated, and, had facilities for blasting been at hand, no doubt this bar would have been found to contain 1,000,000 cubic yards, according to an expert estimate. Another creek showed 6000 cubic yards at $10 per yard. The pans averaged as follows per cubic yard: lowest (from top dirt), 17 cents; highest, $467.25. A most conservative estimate was $5 per cubic yard.

At the time of the purchase the cost of working a sluice of eight men was about $8 per day. Each cubic yard cost $1.50 to be mined, and netted its owners, as above stated, $3000 per month. Improved methods of hand-working have lessened the cost of production one-half. With hydraulic working the dirt can be readily handled for less than 15 cents per cubic yard. Compare cost and product of hydraulic mining in California with possibilities in Surinam! According to a report of hydraulic working of thirty-three California mines, the yield averaged a trifle less than 12 cents per cubic yard, while 39 smaller mines, worked by the same system, averaged less than 3 cents. The highest average above came from a small bar, less than 1500 yards, yielding $16.50 per cubic yard. Then compare the difference of fineness of the gold. The best authorities state that the average fineness of California gold is from 880 to 885 parts in a thousand. Twenty-five samples from different localities in Surinam, given to a United States assayer, showed the fineness of the gold to be 961 gold, and 34 silver, or, 995 parts of precious metal in a thousand. This extra percentage of value, it is claimed, is sufficient to cover all mining expenses.



GOVERNMENT BUILDING—SURINAM.

The possibilities in Surinam for placer and quartz mining are unlimited. It is my firm belief that there are spots yet unexplored that will range far ahead of any now known. But without American push and capital success cannot be hoped for. The government has done practically nothing towards opening up and developing the interior of the colony. A good railway system is needed to reach the far interior. Without doubt concessions of valuable lands on each side of a proposed route could be obtained from the government. There is an unequalled opening for the utilization of electrical power in mining in these vast regions. Placers can easily and cheaply be mined by means of the systematic use of dredging-machines. With pumping plants to furnish water to sluices, many of the low flats now inaccessible for hydraulic nozzles could be mined, under the most unfavorable conditions, for less than 15 cents per cubic yard. A railroad, in addition to promoting the development of mining, would greatly facilitate the shipment of the numerous fancy woods for cabinet-work. With their aid abandoned sugar-, coffee-, and cocoa-plantations, that may now be purchased at merely nominal prices, might again be revived. The cultivation of the banana could be started there more cheaply than in any other tropical part. The present governor is in favor of a progressive policy, and will welcome foreign capital legitimately applied. Investments are safe ; the colony has no debts, all deficits in the revenue being met from the treasury of the home government in Holland.

COURT HOUSE AT SURINAM.

All the highways leading to the gold bush are water-routes. The means of travel are river steamers of light draft, native boats, and "dugouts." Steamers are not able to proceed up most of the rivers beyond 100 to 150 miles, on account of the rapids and waterfalls, all of which are gotten over safely in small boats, by aid of native bush-negroes, who are expert navigators in these wild waters. The nearest placers are about two days from town by steamers,

POLICE STATION AT SURINAM.

and from five to seven in row-boats. Some placers in the upper Sara creek are nearly twenty days distant, owing to the great number of waterfalls to be passed. All provisions, tools, and laborers are transported in this manner. Provisions are packed usually in small boxes or tins of about fifty pounds each, to facilitate carriage from the water-side into the mines. A laborer will easily carry one of these boxes on his head a whole day. All the large mining concessionaires have magazines on the water-side, where provisions are stored, to be conveyed to the placers as required. These are usually taken up into the bush in the rainy season, when the water is high in all the creeks and rivers, for in the dry season navigation is somewhat disturbed by the uncovering of rocks and sandbars which are invisible in the rainy season. Provisions of all kinds are easily obtainable in Paramaribo at fair prices. American beef, pork, flour, and other staples can be purchased there as cheaply as one could import them.

The laborers employed in the mines are the native negroes. Usually lazy, they have to be sharply looked after. The overseers are generally the better class of negroes, half-breeds, and some whites. The wages paid to laborers are from 40 to 50 cents per day, while overseers receive from $20 to $40 per month. These figures represent United States currency values, as the American cent is equivalent to 2½ Dutch cents. Laborers are supplied with food by the contractors from the time they embark for the mines until they return to town. If they are sick or unable to work, they receive no pay, but are entitled to their rations, which for one week are as follows:

6 pounds rice.
2 pounds flour.
1 pound split peas.
1¼ pounds salt fish.
1 pound salt pork.
1 pound salt beef.
1 pint molasses.
3 leaves tobacco.

A supply of medicine is required to be kept on the plains for use of the laborers. The overseers receive a higher grade of fare, and usually mess among themselves, or with the manager. One dollar per day for each man is reckoned sufficient to pay for all labor, provisions, tools, transportation, overseer's salary, and all incidental expenses in mining gold.

The governor of Surinam grants concessions to any one for a term of not less than one, or more than forty years. The lease of the concession can be renewed on expiration. Land is measured in hectares, a hectare being 2.4711 English acres. Any party desiring to prospect government lands files an application for a certain tract, which must contain not more than 50,000 acres, to be selected from the government chart. He is furnished with a duplicate copy of his map, and a lease of his possession for one year. For this there is a small fee. The annual tax on the land for the first year is 4 cents per hectare, for the second year the same, for the

POST-OFFICE AT SURINAM.

THE "PARK" CLUB—PARAMARIBO.

third and fourth years 10 cents per hectare, and for each ensuing year 20 cents, or, in round numbers, 8 cents per acre. The prospector is then allowed to work his grant. Proprietors are required to make their contracts with laborers before the commissary of police. The government has established at convenient intervals on the rivers, between the town and gold-bush, police posts, where all laborers are required to register on going to and coming from the mines. No laborer is allowed to pass these posts going towards

CHINESE CLUB-HOUSE—PARAMARIBO.

town without a written permit from the manager. The government thus keeps track of all laborers, and the police are required to assist in hunting up runaways and returning them to the mines. Laborers are not allowed to carry fire-arms, but proper parties may obtain a permit to carry arms by a payment of $2 a year. The negroes are not generally vicious, and disturbances are exceedingly rare. It is somewhat surprising to know that the vast amount of gold brought down from the bush is virtually unguarded. I have known eighty pounds to be brought down in an open row-boat, in a rusty tin canister, fastened with a common padlock, all hands turning in to sleep nights, leaving the gold in charge of an overseer, also asleep, armed only with an umbrella. I never heard of a case where gold was molested in transit.

SURINAM BANK AT PARAMARIBO.

The miner on government lands can transfer his concession to another, by getting written permission from the governor, who can then give him a new concession for the unexpired term of his original grant. All deeds transferring property are subject to a tax of 2 per cent. on the actual cash price. The government is not responsible for any errors on maps, or for disputes arising between neighboring concessionaries. Fortunately these are rare occurrences and are easily settled by employment of government surveyors or before the courts. Holders of mining lands can use all the timber desired for the prosecution of work, but are not allowed to market any. Timber is found in abundance, embracing many valuable sorts of woods. There is water available for all practical purposes during the rainy season. By storage in dams for use during the dry time, mining can be carried on uninterruptedly throughout the year. The rainfall per year is about 7 feet. A fine is imposed for prospecting and mining without a permit. There is an export duty on gold of 5.38 per cent. and a considerable quantity is smuggled every year.

This territory is now awaiting the talismanic touch of American enterprise. Fortunes are buried amid these tropical wilds. Fame awaits the Stanleys of this "dark continent." Whence came those vast plates of beaten gold with which the ancient Indians adorned their persons, and which, they asserted, came from a mountain in the interior of the Guiana district? Who can tell what became of those people who fled before the rapacious brigands of the conqueror Pizzaro? An old legend states that a train of 10,000 llamas laden with gold to complete the ransom of the Inca of Peru was stopped in the Andes mountains by the intelligence received of his cruel death, and this enormous treasure has been so effectually concealed that not a trace of it has ever been found. Shall we view Raleigh's tale as a myth, or will the broad light of investigation some day prove that the half has never been told?

ICE-FACTORY AT SURINAM.

ENGLISH AND AMERICAN RAILWAYS.

A COMPARISON AND A CONTRAST.

By William M. Acworth.

SECOND PAPER.

WHEN I was in the city of Washington, I was told that, if any American citizen chose to go to the White House on a certain day of the week, he could walk in as a matter of course and shake hands with the president of the United States. To the mind of an Englishman, however fully prepared to accept the doctrine of the equality of all citizens from a political point of view, such democratic simplicity of habit is almost inconceivable. Americans, when they come over to England and find our trains divided up into innumerable small compartments of three different classes, are apt, I think, to forget that our trains are in the main intended for Englishmen, and that the national habits of our country are not those of America. With us it is practically impossible for a gentleman to travel side by side with his tailor; it is equally impossible for the tailor to travel with his own workmen. Though all the three would be made uncomfortable by the attempt, the workman would probably be more uncomfortable than his master, and the master than the customer. That these national sentiments and habits still exist and have to be reckoned with by the railway companies is as indubitable as is the fact that they are nothing like as strong as they were when railways were first introduced two generations back, when it was looked upon as positively discreditable for a gentleman to travel except first-class. The railways themselves have probably done more than any other single agency to break down these class barriers, and one evidence of their success is to be found in the fact that second-class carriages are rapidly dying out in England. In a few years' time we shall probably have only two classes on long-distance trains throughout the country. For suburban travel, however, the three classes will apparently be still maintained, for, though strangers of very different social rank can meet without difficulty, on local trains, where the passengers—many of them season-ticket holders—to a great extent know one another at least by sight, the division of classes still seems as necessary as ever.

But though we move slowly, yet we do move. The absence of lavatories from the trains has long been made a ground of complaint by American critics. Even when they were introduced, they were for a long time attached only to first-class carriages; but now main-line rolling-stock is usually built with lavatory accommodation for third-class passengers as well. Within the last few weeks it has been announced that dining-cars for third-class passengers will be attached to the Scotch expresses by all three routes. It cannot be long before third-class dining-cars are followed by third-class sleepers. But innovations in the English railway world are always handicapped by the fact that our English system was complete in its main outlines fifty years ago; and that for many years past the additions have been of only trifling importance. Take such a question, for instance, as constructing passenger-cars sixty feet long, as in America, or thirty feet long, as with us. Every reasonable person must admit that for a train which is to run solid from, say, London to Glasgow, long carriages on what Americans call "trucks," and we call "bogies," are the best. But for English use they have great disadvantages, and their introduction is opposed to some of our most cherished customs. Most of our trains consist of carriages going to four or five different places, and are broken up and remarshalled two or three times on their journey. If there is not a through carriage from London to Blackburn, the Blackburn people will grumble. Yet to run a carriage weighing five-and-thirty tons for the benefit of possibly half a dozen Blackburn passengers is not to be thought of; and, if we are to have comparatively small vehicles on main-line trains, the others must be kept in some proportion to them. There was a pretty serious accident a short time back caused apparently by putting a small four-wheeled carriage in between two big modern ones.

Take the somewhat similar question of goods-trucks. Americans laugh at our tiny four-wheeled wagons; yet the introduction of their big cars would be almost impossible here except in very special cases. Almost every goods-shed in the country is worked with turn-tables; many of them, as has been said, move their trucks up and down on lifts, and neither turn table nor lift could possibly take in an American car. Then again goods go through, without transhipment as far as may be, from end to end of their journey, so as to avoid delay. Station A, if of any importance, can usually find a ton and a half or two tons of stuff to send to B; but the stations that exchange with one another enough commodities to fill a car the size of those in America every night could almost be counted on the fingers of one's two hands. It is said that such cars could at least be used for coal and iron ore, and so doubtless they might, could the coal-owners and mine-owners be induced to reconstruct their arrangements for loading, could the ironmasters be persuaded to remodel the access to their blast-furnaces, the dock companies be induced to provide new coal-lips, and so on.

Take another point on which the American practice and ours are entirely opposed. Your engineers believe in double-manning or even chain-ganging your engines; with us it is the usual custom—with passenger engines almost the universal custom—always to send an engine out with the same driver. One company, the London and Brighton, carries the principle so far that the name of the driver is painted up inside his engine, and underneath it the number of miles the engine has run between visits to the shops. No doubt our practice requires more engines; but, as I have said, capital is abundant, and there is no difficulty in supplying them, and our people are convinced of the compensating economy in fuel and repairs. In America you may like to wear out your engine in ten years, because in ten years your methods of business may be revolutionized, but our services go on with little change year after year. Until May last, when the broad gage was abandoned, the Great Western had engines running which were designed in 1846,—some of them indeed were constructed only a very few years later. The Northwestern still runs very fast expresses with engines of a pattern which came out in 1862. Why hurry an engine to the scrap-heap by overworking it when it is likely, if fairly treated, to do good work for twenty years longer? For that our engines can stand continuous hard work, if they are put to it, may be taken as proved by the performance of a Northwestern engine, the "Charles Dickens," which has beaten any record in the United States or elsewhere by running more than 100,000 miles per annum for the last eleven years with nothing but the most ordinary shop repairs.

It is evident, I think, that from an abstract point of view our locomotives are more efficient machines than yours. It has been demonstrated, I believe, that they do more work per pound of coal burnt. The explanation is obvious. The work which you give your engines to do is so heavy that, grate-area being limited, you are compelled to force the draught in order to develop the necessary power. In similar circumstances an Englishman divides his train, and works both engines well within their capacity. This implies a larger capital investment in engines and the wages of four men instead of two, but in return there is considerable economy of fuel, and, while capital and wages are both much cheaper in Enggland than in America, coal costs with us something not very far from double what it costs, at least in the middle States of America. Whether it be owing to the great economy as coal-burners of our ordinary engines, or not, I cannot say, but certainly the principle of compounding does not seem to be making much progress in England at the present moment, though one English builder at least has built a great many compound engines for export to foreign countries. Two of our great companies have gone in very largely for "compounds," but no other company seems inclined to follow them. The Northwestern, whose locomotive-superintendent is Mr. Webb, builds engines with three cylinders, two high-pressure outside cylinders exhausting into one low-pressure cylinder underneath the smoke-box. Mr. Wordsell, on the Northeastern, adopts the Wordsell and von Borries two-cylinder system.

Coming to smaller matters, the Americans are, I think, ahead of us in the matter of carriage-lighting. We have a good many trains lighted with electricity, a light which from the passengers' point of view leaves nothing to be desired. But it does not seem likely to come into general use, and will probably remain with us, as in America, a luxury and an advertisement for a few crack trains. Probably we have carried gas-lighting further than in America, so far at least as the proportion of stock goes to which it is applied; but our gas is usually so insufficient, either in quantity or in illuminating power, as to be almost entirely useless to read by for more than a few minutes consecutively. Why the tens of thousands of season-ticket holders around London have gone on year after year, contentedly submitting to sit idle for want of a decent light to read by, is a thing difficult to understand. And if we have suffered for lack of light, we have suffered even more for lack of heat. The Midland Company, the newspapers say, is experimenting with a system of steam-heating from the locomotive. Some company or other has been experimenting any time these past ten years, but meanwhile the passengers on all the companies' lines have merely shivered, and tripped getting in and out on the ridiculous old-fashioned hot-water tins. A stranger might ask why the Board of Trade does not interfere in matters such as these; but the Board of Trade, though it watches with motherly or even grandmotherly solicitude over all questions of the public safety, has never concerned itself with questions of comfort.

Even in the matter of safety it cannot, I think, be said that the influence of the Board of Trade's action has been wholly beneficial We unquestionably have the best system of signaling in the world. The absolute block system is in force almost throughout the length and breadth of the country, and the New York railway commissioners are probably the only body of men in existence who conscientiously believe that any possible time system is as safe as one insisting on an absolute space interval. But having reached this point, we hardly seem likely to attain to anything better. A perfect automatic system should surely be safer than any system which depends on the agency of a signalman. But an automatic system introduced merely as a check on a full staff of ordinary signalmen is hardly worth the money it must cost. The Board of Trade, however, seem inclined to insist on the maintenance of the signalmen, and, as the companies are naturally not prepared to duplicate their service, the development of automatic blocking is making no progress whatever. This latter statement is, by the bye, not absolutely true; for the Liverpool overhead line, which is to be opened directly and operated by electricity, for a service more like that of a tram than of a railway, is to be controlled by an electric block; but in this case the conditions laid down by the Board of Trade were such that no steam railway could possibly have complied with them, for they required that, when certain draw-bridges were opened, the electric current should be automatically cut off from the sections of line on either side. The analogy in the case of a steam railroad would be presumably that the locomotive fire should be extinguished,—a condition which could with difficulty be complied with in practical working.

I have spoken a good deal of the permanence of English conditions. In nothing is this more shown than in the railway staff itself. Most companies make it a rule not to take in any servant above thirty years of age. The bulk of the employés come in as lads, being indeed recommended for employment by the fact that their fathers were in the company's service before them. And if they enter the service as boys, they only leave it as a rule either because they have been injured,—in which case they are commonly provided for from some accident fund,—or else because they are too old for work, in which case they are in all probability entitled to a pension or superannuation of some kind or other. Some companies have carried their provision for their employés to such a point that it is practically impossible for any one in their service to come to poverty except by his own fault. All the great companies spend many thousands a year in voluntary contributions of one kind and another for the benefit of their employés. The only class of what is known as the "uniform staff" who are likely to retire at an earlier period than the regulations require are the men who have been fortunate enough to become guards on the crack expresses. What their income may be, I cannot of course tell; but though they are much too well bred to look as if they expected anything, the habit of "tipping" is so universal in this country, and the "tips" are often so substantial in amount, that I am quite sure the figure must be a very comfortable one.

The organization of the governing body of an English company presents some interesting points of difference from your practice. An English railway is managed by a board of directors, nominally elected by the shareholders, but practically, except in very extreme circumstances, coöperative. None of them need be—very often none of them are—practical railway men. The chairman himself is not as a rule a practical man. Most of our great lines are presided over by peers or country gentlemen. Naturally such an arrangement throws great power into the hands of the official who most nearly corresponds to the American railway president,—the general-manager. As his name implies, the general-manager's duty is to be responsible for the general policy of the company. It is his business to negotiate with the neighboring companies, to decide whether new capital commitments must be incurred, and so forth. Of course theoretically these are questions for the board, but a general-manager who is a trained railway man, with a detailed knowledge of the whole of the facts, can hardly fail to impress his own views on a board of laymen. The general-manager is further the undisputed head of the entire traffic staff, and the traffic department with us includes both the getting the business and the management of it when got,—a combination, that is to say, of the two departments recognized in America of traffic and operating. As the head of the operating department, the general-manager's chief assistant is the superintendent of the line, who also discharges the duties of passenger-agent. His chief commercial assistant is the goods-manager. It will be observed that operation proper is only a sub-department with us. Oddly enough, two functionaries who, in America, I believe, would be subordinate to the chief of that department, the locomotive-superintendent, namely, and the permanent-way engineer, rank with us on a level with the general-manager. The logic of our arrangement is difficult to understand, for it seems clear that the official responsible for working the traffic should have control both over the engines employed for moving it and over the line along which it is moved. It has been said, and I believe with some truth, that the explanation is historical, and that the engineers are, as we term them, "board officers," responsible, that is, to the directors alone, owing to the fact that George and Robert Stephenson, Brunel, and the rest of the great men who founded our railway system, were not traffic officials but engineers.

One point more. Our chairman, owing to his lack of technical knowledge, is usually much less important than the American railroad president. If, however, he possesses this knowledge, he may become almost omnipotent, and this, oddly enough, through the provision of an Act of Parliament which directs that the chairman of the board of directors shall preside at every general meeting of the shareholders of the company. It is obviously most difficult successfully to impeach the conduct of a board, when the chairman of that board, the person mainly responsible for its policy, presides over the meeting and controls its course of procedure. And when from time to time I have read a report of the proceedings at the annual meeting of the Pennsylvania railroad,—I am not aware whether the same course is taken on other lines,—at which a chairman is elected from the body of the meeting, and he invites President Roberts to come up on to the platform and answer any questions his fellow shareholders may ask, I have sometimes thought that, had a similar procedure been adopted in England, more than one of our railways would have been less badly managed than they have been for a good many years past.

The fixity, which, as I have said, before all things characterizes our English railway system, has an important financial result. The established companies can raise unlimited millions by merely holding out their hands for it ; they can borrow money at 3 per cent.; they can sell their preference stock at a price only fractionally lower ; and they can issue ordinary stock on the basis that the subscriber will be content, if he gets something between 3½ and 4 per cent. per annum for his money. On the other hand, for new lines it is almost impossible to raise money on any terms. A railway in the heart of Africa is much more likely to be taken up by the British public than a new line in the heart of England. The reasons for this very curious state of things are various. First and foremost, there have been not a few bitter disappointments. New lines that have promised well have come to hopeless disaster; some of them because they were impossible from the outset; others from sheer incompetence of management; others again, because they were "boycotted" by the great companies, so that they might be starved into surrender. Then again, the existing companies sedulously spread abroad the belief, which, though it is doubtless in their interest that it should be held, they, I am persuaded, hold in all good faith themselves, that no new line can possibly be built to pay. The public have had this idea so persistently dinned into their ears for many years past that it has become part of every respectable capitalist's creed. Then again, the regulations laid down by Parliament discourage all speculative construction of railways. The capital of the concern must not be larger than the amount which is sworn to be necessary for the construction and equipment of the line. Of that capital only one-fourth may be in the form of debentures; the rest must be in shares, and for these shares the purchaser is called upon to pay the full face value. The result is to make the prospect of gain from financing a new railway too slight to attract the speculative financiers. On the other hand, the undertaking is too speculative to attract the support of the ordinary investor; while the need of new railways is nowhere sufficiently acute to lead local men to find the money without regard to the possibility of obtaining a dividend on it.

Railway enterprise in England is in consequence almost dead. The great companies spend many millions every year in improving and enlarging the accommodation on their existing lines; but the construction of new lines is practically at an end. There was a time when the different systems were ready to extend into their neighbor's territory; and these extensions produced in their turn retaliation. But that day is past. Each year the *status quo* becomes more firmly established. Each year the railway interest becomes a more closely organized unit for purposes of common action and joint defence. Rate-wars have been unknown in England for a generation past. But competition in facilities and accommodation has lasted down to our own time. Competition is, however, dropping into the background at present. The talk is no longer of new trains, or of the acceleration of old ones. In its stead we hear much of pools, and percentage divisions, and territorial agreements between rival companies. Another ten years of progress in the present direction and at the present rate will give us a railway system as harmonious and as free from the "waste of competition" as the systems of France and Germany. The school of thought that is in the ascendant in this country at the present moment sees nothing objectionable in the prospect, but rather welcomes a state of things making more easy the transition to that government ownership of all means of communication which it is becoming more and more common to regard as at once inevitable and desirable. It is, however, on competition that our English railway policy has been based from the beginning, and it is by competition that the characteristic excellences of our English railways have been brought out. It is not the men who have the fullest knowledge of our English railway history or the closest acquaintance with the working of the departmental administration of our English government who look forward with the most sanguine confidence to the result of substituting for private competition a monopoly in the hands of a democratic State.

THE COST OF STREET-RAILWAY BUILDING.

By T. William Harris.

IT is the writer's intention herein to give some figures that will be a guide to the investor in estimating the value of any piece of street-railway track, and also to give to those who may wish to build and develop such properties a basis upon which to properly estimate the cost. If any check can be given to the excessive issue of securities,—the ban which has brought so many American enterprises into ill repute ; or if any encouragement can be afforded to the timid individual investor to give with his money the life-blood to America's strongest bulwark,—her public works ; or if any information can be given to any hopeful promoter by means of which he can demonstrate the value of his enterprise and add one more legitimate paying industry,—which must inevitably in electric-railway building bring other development,—then the writer's object will have been accomplished.

First let us take up a simple case, such as is apt to occur. Suppose that it is required to connect a small city of 12,000 people with a village of half its size, three or four miles distant. Local conditions will roughly determine the route ; the franchise requirements generally fix the location in certain streets, while the precise location in the streets, and perhaps the style of rail and general construction, will probably be left to the committee on highways.

Suppose the route be laid down about as follows : Beginning at the Pocono railroad near their depot, up through the City square, where a turn is made at right angles to a street that leads down across a steam-railway track at nearly right-angles, thence out into the country. No curve requiring a guard-rail is met until we come to the outskirts of the village, where we have another right-angle turn, and in the village still another. The first step should be to engage a competent engineer used to such work, and also the best local surveyor. The engineer will wish to ride over the line, then meet the local authorities to get their views, when he will be ready to instruct the surveyor regarding the surveys. The details of the survey, while important, will be passed over as foreign to the subject of this paper. We will suppose that the authorities will allow us to use a T-rail, if we will gravel the part of the track in the city and village, and plank whatever crossings may be needed outside. For turnouts we will suppose that the running schedule will require three,—one in the city, one in the village, and one about half-way between. There will also be a spur at each end. We shall also require a connection with our car-house; we will put in only one curve, and that from straight single track out in the country. We will use a 45-pound rail, with plain joints and good ties, 2′ 6″ between centers. The engineer makes up from the survey the following data upon which to calculate the cost:

		Feet.
Single-track measurement in the city		8,000
Single-track measurement in the village		4,000
Single-track measurement in the country		12,000
Total length measured as single track		24,000
Of this we find three 200-feet turn-outs, making	1,200	
Two spurs, each 100 feet long	400	
Four right-angle curves, 60 feet center radius	433	
		2,033
Deducting these lengths from the total of 24,000 feet we, have a length, which, while it has some slight changes, we may treat as straight track, of		21,967

It may be asked how I get that length of curves. A curve must have a guard at each end. On this road we have seven such places, and one other end has a pair of switches. The track-layer will fix that end all right with an odd bit of rail. I have not deducted the slight pieces of straight track taken out by the tongue-switch and mate, and the steam-railroad crossing, as we must allow something for waste. The turnouts will cost each complete about $375, curves suitable for this track about $1.50 per foot, the steam-railroad crossing $165, and the tongue-switch, mate, and frog $80. For straight-track material rails will cost 45 cents per foot, joints 3 cents, and pipes 2 cents. Ties we will figure at 45 cents each, or 18 cents per foot of track.

Now we have 12,000 feet from which we must, according to our franchise, excavate six inches of the old material and fill in nice new gravel. This being in the streets, old bricks, plaster, broken stone, cinders, and tin cans will be encountered. To dig out and load it into wagons will cost probably not less than 25 cents a cubic yard. This must be carted out along the line to make some little fills. A team will stand still during loading and unloading about half the time, and we will suppose that it will travel 3½ miles an hour the balance of the time, or 16 miles a day, making the carting cost us 20 cents a cubic yard. The new gravel delivered alongside the track we contract for at 75 cents a cubic yard. This gives a total of $1.20 per cubic yard, which, spread six inches deep over a surface six feet in length and nine feet wide, makes 20 cents per foot of track. Out on the line the engineer finds that in addition to the earth already supplied there will be work that will require on the whole of the country part of the line the equivalent of a bank nine feet wide by one foot high, or one-third of a cubic yard. This will be picking down banks, regulating gutters, ballasting, and other such work, at a cost, say, of 21 cents a yard, or 7 cents per foot of track.

The track-laying, if well done on this style of work, will cost about 15 cents per foot, and on curves and turnouts 50 per cent. extra. Next we come to bonding the rails to make the return circuit to the station. Material and labor on this cost about 4 cents per foot of track. As to planking some street-crossings and driveways, the engineer says there will be 800 feet of track to be attended to. Eight hundred feet long, 7 feet wide, and 3 inches thick will give us 16,800 feet, board measure—or 17,000 to allow for waste—of 3-inch plank, which in place will cost $25 per thousand, or $425. Let us sum up what the track will cost :

Straight track per foot, for rails, spikes, and joints	$0.57
Track laying	.15
Bonding	.04
Ties	.18
Total on straight track	$0.87

This is the price that we will often find figured up for the whole line,—first, by those who know no better ; second, by the promoter who is unscrupulous, and wants to make his road look cheap ; and third, by the investor who has got a few prices in his head from a rail-man and wants to demonstrate that a really good property is bonded too high and must inevitably go to smash, for which reason he, overcautious, refuses to buy the securities and loses a chance for a good investment. But let us count up the extras :

Three 200-foot turnouts @ $375 each	$1,125.00
433 feet curves @ $1.50 per foot	649.50
Two 100-foot spurs	375.00
2033 feet track-laying on curves and switches @ 22½ c.	457.42
2033 feet of bonding @ 4 c.	81.32
One steam-railroad crossing	165.00
Ties for 2033 feet of track @ 18 c.	365.94
12,000 feet track graded @ 20 c.	2,400.00
12,000 feet track graded @ 7 c.	840.00
Planking	425.00

Tongue, switch-mate, and frog for car-house connection	80.00
4½ miles surveying at say $75 per mile	337.50
	$ 7,301.68
To this we must add 21,967 feet straight track @ 87 c.	19,111.29
Making the net cost equal to	$26,412.97
To this add contractor's profit, 10 per cent	2,641.30
	$29,054.27
To this add engineer's fees, 5 per cent	1,452.71
Total cost of 24,000 feet of track, complete	$30,506.98

[Or about $1.27 a foot.]

Exceptions will perhaps be taken to the charge of graveling, as being unusual, but I have put this in (1) to caution inexperienced people who are asking cities for franchises, that they may be careful to have all such matters left out, and not go to Wall street with a franchise so bound up with requirements as not to be of value; and (2) to show the banker and investor where a little change in a franchise can sometimes save a good deal in first cost.

Let us now take up a more expensive case,—that of a small city that has some stone paving and hopes to have more. They say that we must use a girder rail on the whole line, and on all but two streets put on chairs or otherwise elevate it so as to leave room on top of a tie to bed a paving-stone. We will adopt rails weighing about 50 pounds per yard, which are usually sold by the foot, and the price includes joints and spikes. We will place our ties 2′ 6″ on centers and use chairs; tie-rods we will put in on the track requiring chairs, once in ten feet. Our engineer reports as follows:

	Feet.
Straight track on chairs	18,000
Straight track direct on the ties.	3,000
Curved track requiring guard-rails	1,000
Two railroad crossings	
Four 200-foot turnouts, equal to	1 600
Three sets of tongue-switches and frogs for branch-offs	
Total length of line, measured as single track	23,600

Of this he finds 3000 feet already paved with stone. It matters little whether this is cobble, limestone, hard sandstone, trap, or granite, for our present purpose, as we have simply to relay it and furnish some little new sand. The cobblestone may cost a little less to relay, but will require more sand. Usually the authorities will allow us to use the old sand to bed the stone in, if we furnish nice new sand to cover off our paving. For this purpose will be required at least two inches in depth over all the pavement relaid, which will usually be nine feet in width or one square yard per foot of track. Some man will say that we do not have to pave 400 square yards in paving a 200-foot turnout. Let him fuss with a turnout once, doing probably one side at a time, with the bother of paving round the frogs and switches, and he will not want any cut made in the item of labor for his paving. Let us look at the prices and see what this piece of work will cost:

Straight track on chairs, 18,000 feet @ 65c.	$11,700.00
Straight track on ties direct, 3000 feet @ 65c.	1,950.00
Curved track, 1000 feet @ $2 40.	2,400.00
Four 200-foot turnouts, (1600 feet) @ $650	2,600.00
Three sets switches and frogs @ $175	525.00
Two steam-railroad crossings @ $170	340.00
Chairs for 18,000 feet straight, 1000 curves, and 1600 feet turnout @ 32c.	6,592.00
Tie-rods for 20,600 feet @ 3c.	618.00
Track-laying, 18,000 feet straight @ 25c.	4,500.00
Track-laying, 2600 feet curves and turnouts @ 37½c.	975.00
Track-laying on ties direct, 3000 feet @ 20c.	600.00
Repaving, 3000 feet @ 23c.	690.00
New sand for repairing, 2" deep or 166 cu. yd. @ $1.25	207.50
Bonding, 23,600 feet @ 4c.	944.00
Ties, 9440 @ 45c. each or 18c. per foot of track	4,248.00
Surveying about 4½ miles @ $75 per mile	337.50
Total net cost	$39,227.00
Add contractors' profit, 10 per cent	3,922.70
	$43,149.70
Add engineer's fees, 5 per cent	2,157.50
Total cost of 23,600 feet of track	$45,307.20

[Or very nearly $2 per foot of track.]

We have a track good enough for a city of say not over 40,000 people, especially if the road is a new one, the earning capacity of which remains to be demonstrated. It has been assumed that this track has been built in gravel streets, but if there should be a macadam surface on these streets, making excavation difficult, or if they should be of clay so that the road-bed would have to be graveled, the cost would be greater, of course; but usually $1000 per mile will cover a good deal of such work.

Let us now look at still another style of construction for this track. Suppose that instead of chairs we should put a longitudinal stringer 4"x4½", laid on the 4½" face. This might be of Southern yellow pine, vulcanized or creosoted, supported on rather better ties than we had before, costing, say 50 cents each. But on account of the additional strength of the stringer, the ties would not need to be nearer than one in every four feet. The ties and stringers can be connected with rolled steel knees, and the rails spiked to the stringers with reverse-pointed spikes. The labor on this work will be a little more than before. There is a good chance to tamp the whole length of the stringer, and the stringer will also afford a lateral support to the paving stone. On curves the timber is sawn in strips 1½″ to 2″ thick; three of these are put together, bent to the proper radius, and thoroughly spiked and bolted together, when they will hold their shape pretty well after being taken from the mold. The writer has done this successfully with cypress lumber at Savannah, Ga. We will only take up the cost of one foot of straight track and compare it with the chair construction, as follows:

	Chair construction.	Stringer construction.
Rails, spikes, and joints	$0.65	$0.65
Rods	.03	.03
Chairs	.32	...
Ties	.18	.125
Bonding	.04	.04
Labor	.25	.30
Stringers, 4″x4½″, pine, treated at $30 per M	...	.09
Knees and knee-spikes	...	.10
Total per foot	$1.47	$1.335

In my opinion the stringer style of track is far ahead of the chair construction. I am well aware that this will be criticised very strongly by the makers of chairs, but let any one put two rough surfaces of iron together and subject them to any jar, no matter how slight, and see the result at the end of a few months. The chair-men may say that I have put too high a price upon my chairs, but they will hardly agree to furnish really good ones for less. They may say that I use them unfairly in putting the ties with chairs 2½ feet apart and the others 4 feet, but let us see how the bearing surface that we can tamp up solidly compares in each case. Consider one foot of track, chair construction: ties 7′ long, 7″ face, 2′ 6″ between centers=235 square inches per foot of track. In the stringer construction, stringers 4½″ wide, ties as before, only 4′ between centers=255 square inches per foot of track. Besides, we have figured the tie in this construction as being worth 5 cents more than the others, so we may have an 8″ face on that. The chair-men may say that they tamp under the foot of the rail; if you stand over the work constantly, you may get some little work done on this, but it is a very hard place to get much good out of the labor, as it comes above the bottom of the paving-stones. The pavers may be instructed to fill and ram that space with their hammers, but they cannot do it well enough to be of value. Now that the vulcanizing process gives us clean and durable timber, free from many of the objections of the older processes, there can be no excuse for not using some sort of a preserving process on stringers.

The writer once had a contract to rebuild a piece of track subject to a very heavy traffic; a splendid girder rail was used, weighing at least seventy pounds a yard, and the ties were good oak and chestnut, but what was put between them? It was an untreated spruce stringer. I remarked to the engineer that he had a bad piece of meat between two good slices of bread in his sandwich, but the great and glorious public eagerly buy up securities founded on such a construction, never stopping to ask where the end will be, or taking independent professional advice as to the durability of the construction which their money goes to pay for.

Here I would urge upon those who are to build and those who are buying securities to look well to the *ties*. Suppose we have a 4"x6"x7' tie, four feet between centers,—and this is not an uncommon case,—what bearing per foot do we get? Only 126 square inches, a poor sort of bearing for a foot of an electric railway. Then, too, that tie is buried out of sight and cannot be tamped up now and then like a tie on a steam-road. A friend who has been a civil engineer on a steam-road now figures out that an engine weighs a great deal more than an ordinary electric car. He then goes at car-mileage, and stops, wondering where his mistake is. Somehow the electric cars give the track a great deal of work, and he cannot be right in his figures, but my friend has made no mistake. There are cases where we have to pass a great many electric cars over a piece of track in twenty-four hours, and there are the teams, often heavily loaded, which bang down on a piece of track from a high paving stone, giving a very intense blow.

But I began to talk about ties. We started in with a 4"x6"x7' tie and found that it gave very little bearing surface per foot of track. How is it best to change this? We do not want to make our tie much longer, as we must keep our excavation, in crowded streets, as narrow as possible. As for thickness, if the rail is not very high, or is held by rods or braces so that it has but little tendency to turn over, it will not pull hard on the spikes. The case is different from a steam railroad, where the heavy drivers of an engine will spring almost any rail and cause a spike to draw. But in electric work we have an immense number of light, rapid blows; our track acts more as a unit and we do not need so much strength in our spike, but we do need bearing surface, and the spike must not prick through the tie and allow the point to split out a sliver on the bottom of the tie. Usually a tie 4″ thick will do for light rails, 4½″ for medium weight, and 5″ and over for very heavy and high rails that require spikes of great holding power. Thus we can give our track a good amount of bearing per foot without making it very expensive. Suppose again that we have a good rail in hand and make the tie 4″x9″ instead of 4″x6″. We can tamp the 9″-tie with a very little more labor than the 6″-tie, and it takes the same number of spikes; but, when it comes to the matter of tie-holes and spiking, we find a saving over increasing the number of ties; besides, a broad tie does not cut into the ground as a narrow one does. Any old section-boss who has tried to keep a piece of track in place during heavy rains, where he had only a clay bank to work on, will tell you to put in big ties,—great wide ones.

Lately I saw a rail that must have weighed over 100 pounds to the yard, laid for an electric railway, but they were putting under it little bits of ties,—mere whipsticks. I suppose that the managers thought their duty to the stockholders was done when they bought that rail, and they never stopped to think of its support, buried out of sight, although this was the most vital point of all. Or perhaps they felt sure that the rails would sell their stuff for them and trusted to the penuriousness of the purchasers to keep them from expert examination. An ordinary steam railroad will have about 380 square inches of tie-bearing surface per foot of track, and we must come as near it as we can with our electric roads, either with ties alone, or by using stringers under the rails.

We may now take up a case of still more substantial and intricate construction. It is desired to build a double track through a city street, from which a double track leads off, giving us two cross-overs, besides a lot of single track and turn-outs in the outskirts of the city. The requirements are for what we will designate as Class A, with 10″ above the top of tie to top of rail, as the paving stones are to be 7″ to 8″ deep; and for what we will designate as Class B with 6″ above the top of tie to top of rail. The survey is made and turned over to the engineer, who makes up the following schedule upon which to base estimates:

		Feet.
CLASS A.—	Straight track	20,000
	Cross-overs	200
	Curves requiring guard-rails	800

Of this track 15,000 feet are now paved, and we must repave it, and 5800 feet we are required to pave new.

		Feet.
CLASS B.—Straight track in Macadam		15,000
Straight track in gravel		5,000
Curves requiring guard rails (in Macadam)		500
Six turnouts, 200′ each (in Macadam)		2,400
Pairs of tongue switches	5	
Pieces of special work	13	

It is evident to one accustomed to such work that, having taken hold of a job in a large city, we must provide for solid business. Let us use a 70-pound girder rail, 6″ high. In Class A we will have a 4½ x4′ Southern yellow-pine stringer, and on the whole of the line we will use a 5″x9″x7′ Southern yellow pine tie, treated as before. Here another problem is met. We have all along merely bonded our track, but here we have many cars, and we must attempt to fix up a better return. We will put in a good ground wire and tie it to each end of each rail and special piece. We may also bond the rails as before, and put in good grounds along the line. This is all that we can do unless we run an independent overhead return, which is rarely needed. In this estimate we will figure our return as costing 12 cents per foot of track, which will usually cover the cost in such cases. Such ties are expensive, I know, but we want a good foundation to build on and we do not want a heavy repair-bill for a long time to come. The estimates will be :

CLASS.	Cost.
A.—Straight track, 20.000 feet, @ 90c	$18,000.00
Two cross-overs, (200 feet) @ $600.	1,200.00
Curves, 800 feet, @ $2.60	2,080.00
B.—Straight track, 20,000 feet, @ 90c	18,000.00
Curves, 800 feet, @ $2.60.	2.080.00
Six 200-foot turnouts, (1200 feet) @ $800	4.800.00
Five pairs tongue-switches @ $175	875.00
Thirteen pieces special work @ $60	780.00
Ground-wire, or return, 44.200 feet, @ 12c.	5.304.00
A.—Track-laying, 20,000 feet, @ 35c.	7,000.00
Track-laying on curves, etc., 1000 feet, at 52½c	525.00
Extra excavation and disposal of waste on new paved work, 5800 feet, @ 10c	580.00
Repaving, 15,000 square yards @ 25c	3.750.00
New paving (a hard matter to estimate off-hand) 5800 feet, @ $3.50	20,300.00
Ties, 4′ c. c. @ 80c	4,200.00
Stringers, 4″x4½″, at $30 per M	1,890.00
Knees and knee-spikes, @ 10c per foot.	2,100.00
Sand for repaving 1500 square yards, 2″ deep	1,041.00
B.—Track-laying, 15,000 feet in Macadam, @ 35c	5,250.00
Track-laying, 5000 feet in gravel, @ 30c	1,500.00
Track-laying, 3200 feet curves and turnouts, @ 52½c	1,680.00
Ties on 23,200 feet, 2′ 6″ c. c. @ 80c	7,424.00
Rods on whole line, 44.200 feet, @ 3c	1,326.00
Surveying (part of the line is double track, and thus cheaper)	600.00
	$112,285.00

Amount forward	$112,285.00
Contractor's profit, 10 per cent	11,228.50
	$123,513.50
Engineer's fees, 5 per cent	5,675.50
Total	$129,189.00

This is a little less than $3 per foot, and we have a first-class track for ordinary heavy traffic. Of course the semi-grooved rail, or electrically-welded chairs or joints, would cost more, but it has been the writer's aim to give such examples as come up often, and such estimates as are likely to be of real value to a large number of readers. Some may have followed me to this point, saying from time to time that estimates were not given on work good enough for them, but that at last, when one was given to suit them, they found the price too high. I do not want to discourage them; they may be wrong in their requirements. If the matter has any good points at all, consult the nearest engineer skilled in this kind of work and he may show you a way out of your trouble. It is not the actual *cost* usually that founders any enterprise, but the *water*.

It having been the writer's privilege for eight or ten years past to be much on the moneyed streets of the Eastern cities, a word to out-of town promoters who want to sell bonds may not be amiss. To such I would say: start with the idea that, while it is not an impossible thing to do, it is hard work to sell unknown securities in the large cities. If possible, first build the road. Then make a good trust company—in New York, for example—trustee of the mortgage, taking care that the mortgage is drawn by a competent attorney. Then take to the money center the best introductions obtainable, and you will find that people have time to listen to you. But if you go with nothing but a scheme in your mind, you will find it up-hill work all along. If material is advanced, it will be on very long prices, and finally some construction company will gather you in, and it will be found when the road is built that you have paid a tremendous price for the property, and then to pay the interest and the repair account on the slop work will keep you poor forever. A road skilfully designed for the traffic at hand, and built for cash, is usually good property. But a poorly-designed, poorly-built road, with a liberal dose of "water" in the securities, is a disastrous undertaking for the first owners and an injury to every good, well-balanced enterprise in the country.

Sincerely Yours Elisha Gray

PROFESSOR GRAY'S NEW TELAUTOGRAPH.

By William Maver, Jr.

IN the operation of telegraph systems generally, whatever the form of device used or the method of transmission, the message reaches the receiving-station in the form of dots and dashes, which have to be translated into words by operators trained to the work. There have been many attempts, however, to utilize the idea of an apparatus for writing at a distance in fac simile. There is now on public exhibition in various cities of the United States an apparatus for this purpose, invented by Professor Elisha Gray and termed by him the "telautograph," the result of which has been such success as to justly direct renewed attention to the subject of what may be called writing-telegraphy. In order that the merits of this late invention may be properly estimated, it will be well to consider the work of some of the earlier experimenters in this line.

Fifty years ago Alexander Bain, of Edinburgh, devised an apparatus whereby written or printed characters formed in metal and set up at a sending-station were reproduced in fac-simile at a receiving-station through the agency of electricity. An idea of the manner in which this was accomplished may be gathered from Figure 3. The letters at the left, composing the word B A I N, were inserted in the path of an electric current for which five wires were employed. The ends of the wires were caused to pass over the metal letters at a given rate of speed and at the same time the ends of the wires at the receiving-station were caused to pass over chemically-prepared paper at a corresponding rate. While the wires at the receiving-station were passing over the metallic letters, the electric current flowed in the wires, and at such times the electric decomposition of the solution contained in the paper ribbon at the receiving-station proceeded, forming brown or blue marks on the paper, according to the nature of the material used. Contrariwise, when the wires left the metallic letters, the current ceased to flow, and decomposition of the solution stopped. The cause of the broken appearance of the received letters in Figure 3 is thus accounted for. Had the wires been more numerous, or the metallic letters smaller, the breaks in the received letters would have been

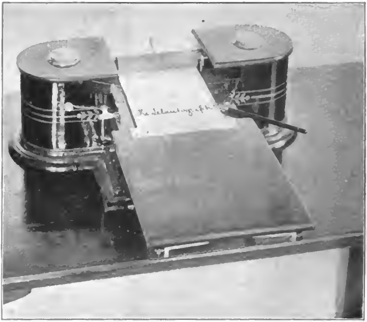


FIG. 1—THE TELAUTOGRAPH TRANSMITTER.

less pronounced. This statement is illustrated by reference to Figure 9, in which the characters are made up of lines much closer together. In some later forms of telegraphy in which the foregoing principle has been employed the characters to be transmitted have been written on tin-foil in insulating ink, and a terminal of the line wire has been caused to pass over the surface thus prepared, with a result practically similar to that attained by Bain. It is evident that one is not limited to written characters in telegraph systems of this kind, since even small pictures may quite as readily be reproduced.

One of the best known of the writing- or copying-telegraph systems is that invented in 1856 by Abbé Caselli, of Florence. The apparatus employed at each station in this system is shown by Figure 4. It consisted of a pendulum six feet in length, with an iron bob weighing sixteen pounds, suspended from an iron frame. The pendulum was caused to oscillate between electromagnets, shown opposite the bob, by the alternate opening and

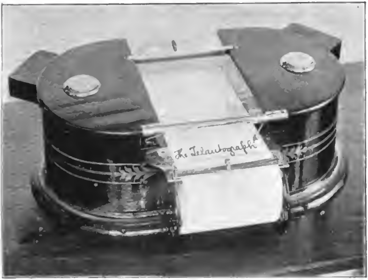
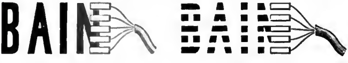


FIG. 2—THE TELAUTOGRAPH RECEIVER.

closing of a local battery, controlled by a "circuit-breaker," represented at the upper left corner of the figure. At each side of the frame was placed a curved iron tablet, over which a pen attached to the main-line circuit was caused to pass. One of these tablets served as a transmitter, the other as a receiver. The pens received their motion from the pendulum by means of rods and levers, only one of the pens, however, being connected to the pendulum at once. The tablets were also, by suitable mechanism, given a slow motion at right angles to the crosswise movement of the pens. A message to be transmitted was written in ordinary ink on silvered paper which was placed upon the surface of the transmitting tablet. A sheet of chemically-prepared paper of similar size was placed upon the receiving-tablet at the distant station. The movement of the pendulum at each station then produced a correspond-



The Sender. The Receiver.

FIG. 3—THE BAIN CHEMICAL TELEGRAPH.

ing movement of the transmitting- and receiving-pens over their respective tablets, and as a result current flowed or stopped in the circuit according as the transmitting-pen passed over the inked or clear surface of the silvered paper. The right-angle motion of the tablets was so arranged that the consecutive passages of the pens across the paper were separated by a very small space, as will be seen by examining the lines forming the characters in the specimen of the work done by this system, shown in Figure 9. A receiving-tablet showing a partly-completed head is illustrated in Figure 5. This system was operated practically between Paris and Marseilles, a distance of 560 miles.

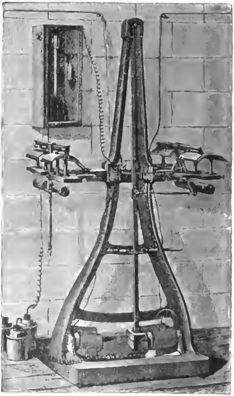


FIG. 4—CASELLI'S COPYING-TELEGRAPH.

Modifications of this system have from time to time been introduced,—for example, the Denison auto-telegraph,—but apart from Caselli's no copying-telegraph has been practically employed to any notable extent. The Denison auto-telegraph was virtually a miniature Caselli copying-telegraph, the pendulum and tablets of the latter being replaced by small arms which were caused to traverse, at a high rate of speed, paper ribbons at the receiver and transmitter. The arms were operated by a "circuit-breaker."

Autographic electric systems — or telautographic systems, strictly speaking—may be distinguished from fac-simile or copying telegraph systems by the fact that in the former the characters are electrically transmitted and reproduced at the receiving-station at the very time they are being formed by the pen or pencil in the hands of the operator at the sending-station. It is plain that any device whereby this result can be accomplished, easily, quickly, and without intricate apparatus, will be of much utility in a variety of places. For instance, by its means a merchant could send instructions from his office to his factory; brokers could give quotations and execute orders without dispute,—the correspondence being virtually, as the name of the system implies, in the handwriting of the contracting parties; sketches requiring despatch could

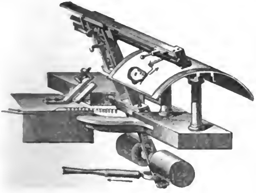


FIG 5—CASELLI'S RECEIVING TABLET.

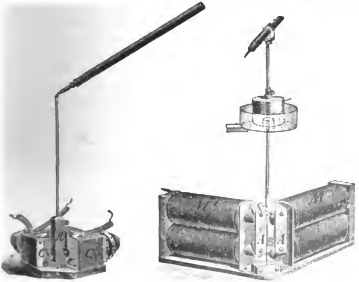
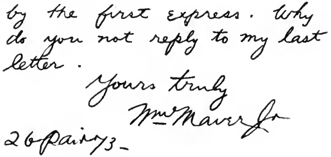


FIG. 6—ROBERTSON TRANSMITTER AND RECEIVER.

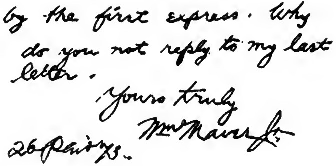


by the first express. Why
do you not reply to my last
letter.
Yours truly
Wm Maver Jr
26 Pair 73 -

FIG. 7—TELAUTOGRAPH MESSAGE AS WRITTEN.

be transmitted in the act of preparing them. If it be said, as regards the Morse telegraph and telephone, that orders and quotations can as quickly be sent, the reply may be made that, in the case of the telegraph, expert operators are necessary; while in the case of the telephone the difficulty in the reception of certain articulate sounds, as well as the absence of a record, diminishes its usefulness in many transactions.

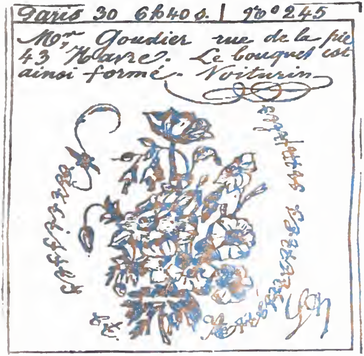
The first inventor in the line of telautography, I believe, was Mr. E. A. Cowper, of England, who termed his invention, made in 1874, a writing telegraph. In this case the transmitting-pen was held as in ordinary writing, the desired characters being placed on a strip of paper, which was caused to move slowly to the left as the letters were formed. At the same time a pen at the receiving station was caused to form characters corresponding to those made by the writer of the message. This pen was supported by a rod attached to an armature between two small electro-magnets, and



by the first express. Why
do you not reply to my last
letter.
Yours truly
Wm Maver Jr
26 Pair 73 -

FIG. 8—THE ABOVE MESSAGE AS RECEIVED.

its movements depended upon variations of the magnetic strength of those magnets. These variations of magnetic strength so acted upon the armature as to give the receiving-pen all the motions of the transmitting-pen. Each of the electro-magnets referred to was placed in a separate circuit, and the variations in their magnetic strength were brought about by variations in the strength of current flowing in the circuits, which latter variations were produced by changes in the electrical resistances of the circuits; it being well known that the strength of current in a circuit varies proportionately with the resistance.



Paris 30 6h40 s. | N° 245
Mr Goudier rue de la pie
43 Havre. Le bouquet est
ainsi formé. Voiturin

FIG. 9—WORK DONE BY CASELLI'S TELEGRAPH.

The theory on which Cowper's system was operated is really that of compounding the movements of a point in two directions, the one at an angle to the other, the movement of the point being the resultant of the two movements.

The following illustration may help to make the operation of the receiving-pen clear. Suppose a buoy to be anchored by an elastic rope, in a river opposite the mouth of a tributary whose waters enter the main stream at right angles to the direction of the former. If the force exerted by the water flowing in both streams be equal, it is plain that the buoy will be moved, against the pull of the elastic rope, diagonally between the directions of the two streams, and if this force be diminished the elastic rope will retract the buoy to its normal anchorage; but if the force of one stream be greater or less than the other, the buoy will be deflected to a position corresponding to the resultant force of the two. Hence, if means should be devised whereby the outflow of each stream could be simultaneously regulated by the turning on or off of valves, or gates, by means of suitable levers, it is obvious that the buoy might be caused to take any desired position, or to move in any desired curve, within given limits, by one having control of the lever.

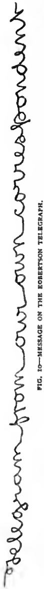

Telegram from our own correspondent

FIG. 10—MESSAGE ON THE ROBERTSON TELEGRAPH.

The Cowper writing-telegraph was never practically used, and little was done in the line of telautography until about 1884, when Mr. J. Hart Robertson, of New York, working upon the general principles laid down by Mr. Cowper, succeeded in producing various important improvements in the transmitting and receiving instruments. Further improvements in the transmitter were introduced by Mr. H. Etheridge, of Pittsburgh, Pa., and writing-telegraph circuits, embodying these improvements, were placed in practical operation in Pittsburgh and in Rochester, N. Y.,—in the latter city for reporting baseball news, and on private lines.

On these circuits the sender used a pen whose movements were limited to a space not exceeding an inch square,* and the movement of the receiving-pen was confined to a corresponding area. The transmitter and receiver employed in this system are shown at the right and left, respectively, of Figure 6. In writing by this method it was necessary to form the characters, one on top of the other, so to speak, since, as I have stated, the movement of the pen was confined to so limited an area, the platen on which the pencil rested being stationary; and no little skill was required in the use of the sending-pencil to produce intelligible writing at the receiving end. This skill could be acquired by practice, though I must confess that, after having had several opportunities, I did not become expert enough to do any work at all comparable with the specimen of writing done by the Robertson-Etheridge telegraph shown in fac-simile in Figure 10.

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* The transmitter consisted of two rows of small disks of carbon, placed at right angles to each other. The disks were placed within suitable cases, side by side. Each row of disks was included in an electric circuit, and one of the electro-magnets, similar to those used in Cowper's telegraph, was placed in each circuit at the receiving end. The transmitting-pen was provided with projections on its sides opposite the carbon disks. As the pen was moved in the act of writing, these projections pressed, more or less strongly, against the carbon disks, and as the electrical resistance of carbon decreases quite materially under pressure, the consequence was that the strength of current in the respective circuits was varied according to the movement of the pencil, with the result already outlined. The writing-pen employed was carried on the flexible elastic rod, as shown. The drum-

It is not much to be wondered at that this system was not more generally adopted. Its extension was doubtless hampered and its sphere limited by the amount of skill necessary to use it, and by its inability to reproduce any but written characters. The plan upon which the movements of the receiving pen was based—namely, the increase and decrease of current strength on the circuits, or variable resistance method—also militated against its success, especially on long circuits.

In the telautographic system just completed by Professor Elisha Gray,—to whom, I believe, the term "telautograph" is due,—many imperfections and defects of previous writing-telegraphs, including his own earlier inventions, have been avoided. For instance, the improvement in the matter of writing has been carried to such an extent that one who sees the apparatus for the first time, as in my own case, may take the sending-pencil, and, without moving the paper before him, write or sketch, upon a space five inches wide by three or four inches long, characters which will be at once reproduced in ink in exact fac-simile at the receiving instrument. Figure 7 is a specimen of writing done carefully on this instrument at my first attempt. Figure 8 represents the same writing as it appeared on the receiver. In other words, Professor Gray has succeeded in producing what would be termed a "page-and-line" writing-telegraph system, in contradistinction to a single-line or strip writing-system, and by means of which any one who can handle a pen or pencil may have the work of his hand electrically

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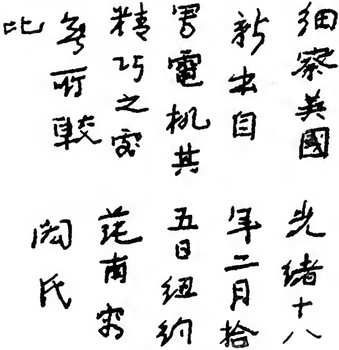
shaped vessel shown midway up the rod carried a small quantity of glycerin, in which a "damper" attached to the rod was placed to steady the movements of the pen and to prevent it from wavering.

reproduced at a distance, by a method not materially affected by ordinary changes in the insulation of the circuit.

To accomplish these results, Professor Gray has abandoned the variable-resistance method of obtaining the desired movements of the receiving-pen, adopting instead what is termed a "step-by-step" method, which will be referred to on another page. The principle of "compounding the point," previously referred to, is retained, however, but, as compared with the writing-telegraph system of Cowper, has been greatly amplified, as must be obvious in view of what has been said as to the range of the writing- and receiving-pens.

If it were within the scope of this paper to give a detailed technical description of Gray's improved telautograph, I would be debarred from doing so by the fact that certain of its important features have not yet passed through the patent-office, and that the mechanism of the apparatus in its entirety is therefore not accessible for inspection. But it will be possible with the aid of illustrations to give a fair idea of the manner of its operation. The transmitter and receiver are represented by Figures 1 and 2, the essential instruments and mechanism being enclosed in the iron boxes shown. The paper on which messages are written and received is in a continuous roll, as indicated, about five inches wide.

In writing, an ordinary lead pencil may be used. Near the point of this pencil two silk cords are fastened, as indicated in the figure. They diverge from the pencil at right angles to each other, and enter the iron case through suitable apertures. Each cord is wound upon a small drum mounted upon a vertical shaft, each shaft carrying also a small toothed wheel. Each wheel, in moving, operates an escapement which, in turn, causes an electrical contact point to oscillate in such a manner as to send pulsations of positive and negative polarity over the two main line wires employed for the transmission of the writing. The number of pulsations thus sent over the wires depends upon the rate at which the toothed wheels are caused to rotate by the movements of the silk cords around the drums. If the pencil is moved one inch in the direction of either of the cords, 40 teeth of the wheel attached to that cord will be caused to pass a given point, and 40 pulsations of each polarity will flow over the line wire. It will depend upon the direction in which the pencil moves whether both the toothed wheels will be rotated at once,—causing pulsations to pass over both of the transmitting wires at once,—or whether a greater or less number will pass over either wire. Likewise the movement of the receiving-pen will depend upon the rapidity of these pulsations and upon the number that pass over the respective main line wires, for the telautograph receiver is an instrument operating in a reverse manner to that of the transmitter, as the receiver of the telephone acts reversely to the transmitter. In the latter case air-waves started by the voice cause the diaphragm of the transmitter to set up electrical waves



细察美國新出自写電机其精巧之实無可比較

光绪十八年二月拾五日纽约莼甫寄閎氏

FIG. 11—CHINESE MESSAGE BY THE TELAUTOGRAPH.*

of corresponding quantity in the wire ; these electrical waves in turn cause vibrations in the diaphragm of the telephone-receiver similar in quantity to those of the transmitter, and the latter institute air vibrations, which are reproduced in the ear as sound. In an analogous manner, depending upon the movement of the sending-pencil, the telautograph transmitter sets up in the wires pulsations of a given frequency, which pass over the wires and set up pulsations in the receiving instruments, which pulsations in turn are caused to move the receiving-pen in a manner precisely similar to that of the transmitting-pencil. But whereas in a telephone receiver the amplitude of movement of the diaphragm is much less than that of the transmitter in the telautograph receiver, the amplitude of movement of the pen is exactly equal to that of the transmitting-pencil. Its movement could be made greater or less than the transmitting-pencil, however, by adjustment of the parts, in a manner analogous to that by which this result is accomplished in the pantograph. Indeed, as Professor Gray has suggested, his invention could properly be termed an electric pantograph.

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*A close examination of the newly invented self-writing electric machine reveals the fact that in point of ingenuity and convenience it is beyond compare.

YUNG WING.

New York, 31st March, 1893.

To bring about the result mentioned at the receiving station, two "polarized" relays and certain other apparatus are employed. One relay is placed in each of the main wires. Each relay controls an escapement which in turn engages with a toothed wheel on a vertical shaft carrying a small drum, this mechanism corresponding to that in the transmitter, already described. To each drum is attached an aluminum pen-arm by means of cords, on the principle of the well-known bow-drill. The pen-arms are hinged together at the writing point, as may be seen in the figure. A small rubber tube, one end of which rests in an ink-well, passes through one of the pen-arms to the writing-pen, which is a small glass tube placed at the junction of the aluminum arms. As the pen passes over the paper the ink is deposited, the supply being maintained by capillary action. The toothed wheels in the receiver are given a tendency to rotate by any suitable motive power (at present a small electro-motor is employed), but they are held in check by the escapements. Hence, as the movements of the escapements are governed by the polarized relays, which in turn are controlled by the toothed wheels of the transmitter, every movement or "step" of those wheels will be duplicated by the toothed wheels in the receiver. Consequently, the movements of the transmitting-pencil in any direction will be followed by the receiving-pen. If, to borrow the language of Professor Gray, the sending-pencil be started from the center of the writing tablet and be caused to describe a line to the right at an angle of 45 degrees from the horizontal, only the right-hand escapement of the receiving instrument will be operated. Contrariwise, if the pencil should be moved from the center, drawing a line to the left, at a similar angle, only the left-hand escapement at the receiver will be operated. If the pencil be moved vertically,

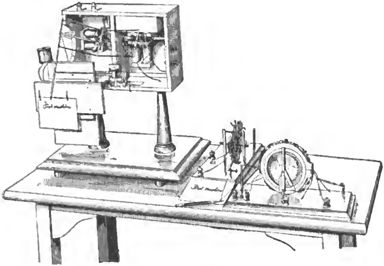

FIG. 12—GRAY'S FIRST MACHINE.*

both escapements at the receiver will be moved vertically, and *vice versa*. If the sender should describe a circle with his pencil, the receiving drums would both be acted upon exactly as are the sending drums, and the resultant of the two right-angle motions properly proportioned to each other would be a circle; on the principle of the "compounding of a point," to which reference has been made.

It would seem that the force which drives the shafts on which the drums controlling the receiving-pen are mounted would tend always to move the pen in one direction,—either up or down the paper,—in accordance with the movements of the escapements. That such is not the case is due to the employment of an ingenious mechanism in the receiver, controlled by the transmitter, which reverses the direction of the driving-force of the receiver simultaneously with every change of the transmitting-pencil, as from an up to a down stroke.

As shown in Figure 10, the writing received on the Robertson-

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*This cut shows the first machine, completed early in 1887, from which writing was obtained. It was constructed on the variable resistance plan, but no provision was made for raising or lowering the pen or shifting the paper, these functions having to be performed by the receiving operator. On account of the numerous objections to any variable resistance system this principle was abandoned and the step-by-step principle adopted. Patents were, however, applied for on this machine in the fall of 1886, and notice has just been received from the patent-office that the claims have been allowed.

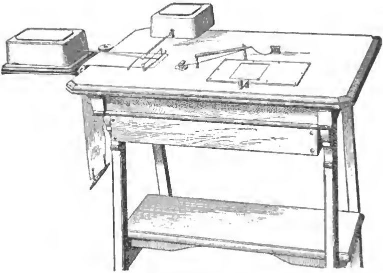

FIG. 13—GRAY'S SECOND MACHINE.*

Etheridge writing-telegraph was continuous, there being no breaks between words. To have separated the words additional electro-mechanism would have been necessary. In the Gray telautograph the receiving-pen is lifted every time the transmitting-pencil is raised from the paper, by means of an electrical device automatically operated by the sender in the act of writing. There are other devices by which the paper is moved forward as required, mechanically at the transmitter and electrically at the receiver. In the performance of these extra functions two additional wires are now employed, but it is understood that provision is being made whereby only two main line wires in all will be required to perform the various necessary functions. The use of four wires undoubtedly would be a drawback, especially in large cities and on long circuits.

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*The second machine was completed in March, 1888, on the step-by-step plan. The sending and receiving apparatus were placed on one table, but each apparatus used its own roll of paper. In this instrument the pen-arms were worked by means of "gripping armatures" which were operated by impulses sent from the transmitting end. This was an extremely complicated machine, the box under the leaf of the table being nearly filled with small pieces of electro-mechanism, but arrangements were made for moving the paper and raising the pen without the aid of an operator. On this machine additional patents were applied for and granted on July 31, 1888, but Professor Gray immediately set to work simplifying the system, and in 1890 brought out the machine shown in the next figure.

A notable feature of the telautograph is that characters of any description, including plans, sketches, etc., in addition to simple writing, may be transmitted by means of it. This opens a field in which such a system might have a monopoly,—the transmission of Chinese and Japanese writing. Since the Chinese "alphabet" consists of many thousands of characters, it would be impracticable to employ such a code of signals as those composing the Morse alphabet for telegraphing in that language. There might be required for a single character, perhaps, fifty dots and as many dashes. When it is now desired to despatch a message in China, the sender imparts, in Chinese speech or writing, the substance of his message to the telegraph-operator, who refers to a code-book containing Chinese characters representing the phases most current among merchants, and transmits in English the numbers corresponding to those phrases, forwarding the numbers to the proper station. There the operator, by the aid of a duplicate code-book, re-translates the message into Chinese and sends it to the addressee,—a practice certainly not conducive to accuracy. A specimen of Chinese writing which was recently transmitted by telautograph in New York is shown in Figure 11.

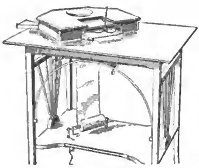
FIG. 14—GRAY'S THIRD MACHINE.*

The claim made for this system that it will not be materially affected by induction from electric-light or electric-railway circuits doubtless is well-founded. It is similar in this respect to such systems as the Wheatstone automatic and other telegraph systems in which currents of alternate polarity of considerable strength, and instruments not very sensitive to induction, are employed. The operation of the telautograph, as at present on exhibition, is quite satisfactory, and, judging by experience had with other telegraph systems, it may be said that, in the adoption of the "step-by-step" method for producing the desired movements of the receiving-pen, the probability of its successful operation in actual practice is much enhanced. It is understood to be the intention of the management to establish telautograph Exchanges in the principal cities, in addition to placing the instruments in offices for "private-line" service. It is intimated that the cost of the service outside of New York city will be somewhat below ordinary telephone charges.

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*Here again the sending and receiving apparatus are combined on one table, and very satisfactory results were obtained, but owing to the delicacy of the parts and the crowding together of the mechanism the instrument was not considered good enough for commercial work, and further experimenting was commenced, which resulted in the production of Professor Gray's new telautograph.

It is obvious that the telautograph could only have reached its present state of development after long experimenting, and by the most careful and accurate adjustment of the mechanism. Some idea of the various stages through which this invention has passed may be gained from Figures 12, 13, and 14, which represent the first, second, and third completed machines devised by Professor Gray. The first machine (Figure 12), completed early in 1887, was constructed on the variable resistance plan, but no provision was made for raising or lowering the pen, or for shifting the paper, these functions having to be performed by the receiving operator. The second (Figure 13), completed in 1888, was constructed on the "step-by-step" plan, but this was an extremely complicated machine, and on that account would hardly have been adopted for practical work in the hands of non-experts. The third machine (Figure 14) gave fairly satisfactory results, but not sufficiently so to satisfy the inventor, who persevered until the new telautograph, now on exhibition, was produced.

THE CARE OF EXISTING HIGHWAYS.

By W. E. McClintock, M. Am. Soc. C. E.

VERY few of the smaller agricultural or manufacturing towns of the United States are in a financial condition to make any extravagant outlay on their existing road-systems. It must be admitted that some very serious mistakes were made when the lines were laid out and the grades adopted; but any attempt to alter these will involve large expenditures of money, which will remove the present possibility of permanent improvement of the roadway. As a rule the roads must be taken as they are now laid out, and the roadway made hard and smooth, so as to reduce the cost of transportation and make travel more agreeable the year round.

The roadway should form a roof over the foundation. When it does, the problem is solved and good roads will be found, provided the proper care has been exercised to prevent any water from flowing under the roadway laterally. The forces which tend to destroy a road are—first, weather; second, traffic. On most of our country roads the weather has far more injurious effect than the traffic. The finer material constituting the wearing surface is crushed under the wheel to be made into mud when wet, and fine dust when dry. If the wearing surface is made of material which will crush easily, it soon resolves itself into dust and becomes worthless, and new must be put on to take its place. The smaller the fragments of the covering, the more easily will they be crushed and the poorer will be the road.

With larger fragments the softer will be more easily crushed than the harder, and with a large amount of travel it will be economy to select only the hardest and best of rocks. Very few of the natural soils are in any way suitable for withstanding either the weather or the traffic. There are localities, however, where the available funds will not permit of hauling either gravel or stone, and the best that can be done is to shape the surface with the road-scraper, to remove ruts and hollows. Where there is little money there is likewise light travel. It is well to bear in mind that vegetable loam or sods are a very poor substitute for gravel, and they had better be thrown to one side instead of being put on the road. Little can be expected from roads built of light dirt; but at the same time, if the side ditches can be opened to a depth of two-and-a half feet below the center of the road and graded so as to permit the water to flow freely to a point of discharge, the roads will be much better, and for most of the year, if the travel is light, they will not be bad.

The poorer the material the more care should be exercised in treating it. The great trouble with roads of this class is that they are permitted to wear almost flat, the side ditches (if any were ever built) are filled up, and what water falls on the surface remains there until it settles into the ground through the road. When the roadway is thus softened, the first wheel that passes over it will make a rut, which becomes enlarged by each succeeding wheel until the whole surface is destroyed. Another error is to give the road such an excessive crown that teams are obliged to keep in the center, which, under the extra wear, soon ruts up and is destroyed. Nothing is gained by giving the center of a road a rise of more than one foot in twelve; and this should be an almost even rise from the gutter, and not all or nearly all at the gutter, as is too often the case.

There are many gravels that will make good roads. Some of these are made up of angular stones so mixed with a fine binding material that they pack firmly almost as soon as placed on the road and will withstand the travel for years. The banks can be readily recognized, as they stand vertically and require at least two picks to one shovel in loading a cart. There is quite a large proportion of stone in these banks over two-and-a-half inches in diameter. These should all be removed before using, or they will make a rough stony road as soon as it begins to wear. It is not safe to trust this to the man who levels off on the road, as he is more than likely to neglect his duty. It is better to screen them out and use them on some piece of road where the depth of fill will hide them entirely, covering with the screened gravel from which all stones have been removed that will not pass through an inclined screen with a one-inch mesh.

Water in any part of a road is an element of destruction, and it must not only be got out but kept out. The rain which falls on the surface of the ground soon disappears from sight to appear again in the nearest watercourse or in springs. If the ground is gravelly or sandy, it passes down to the lower impervious strata; and if the impervious strata lie at a depth of two feet or more, no trouble will be had with water. If clay or hard-pan immediately underlies the surface loam, the water drops to this and then flows down the slope toward the watercourse. Where the road traverses a side-hill constituted as above, trouble may always be expected unless drains are so placed as to intercept the ground-water and carry it off by a new channel instead of under the road. If the road lies partly in cut and partly in fill, it will not be necessary to build more than one drain, and that should be placed on the up-hill side. If the road passes through a section where there are no houses, a side ditch at the side or sides will serve every purpose perfectly well, the bottom to be about two-and-a-half feet below the center of the road.

Ditches should be sufficiently removed from the traveled way not to cause danger to the traveler. If the land is used in such a manner as to prevent an open ditch, a trench can be excavated under the edge of the roadway. Whenever the ground is clayey and wet, drains should be placed on each side, except on a side hill as referred to. The ditch can be dug ten to twelve inches wide at the bottom and fifteen to twenty inches at the top. In the bottom of the trench place small gravel stones about two inches deep, on which is to be laid a drain tile about five inches in diameter, increasing to larger size when a long line is to be laid before reaching an outlet. Fine gravel stone varying from half an inch to one inch in diameter are packed around the pipe, and over it to a depth of about one foot. The rest of the trench can be filled in with any large broken stone or screenings. The stone should be carefully rammed to prevent any future settlement of the road over it. The small round stones around the pipe will prevent the sand or fine dirt from passing through the joints into the pipe, while they offer no resistance to the free flow of water. The common glazed sewer-pipe is as good as any other for this purpose, and, with the bells, will make a better line than will the ordinary tile. Do not use any cement of any kind at the joints unless the drain passes near elm trees, in which case the joints lying within thirty or forty feet of a tree should be carefully cemented with good American cement mixed with sharp clean sand in equal proportions. Great care must be taken in making these joints, as the smallest hole will permit a fine root to pass in, and when once inside, where the air is warm and moist, it will soon fill the whole space. Wherever the road is wet and soggy in the spring, it is safe to say that a drain will be needed.

In building a road of rounded gravel more care must be exercised in laying it on. The best results can be obtained by screening out the fine through a half-inch screen and the coarse through a three-inch mesh. Lay on the stone, varying in size from half an inch to two-and-a-half inches in diameter, to the desired depth, and crown. Cover these with two to three inches of the fine screened gravel.

If the gravel be clean and water washed, a little soil, loam, or hard-pan will materially assist in binding it and make a smooth road in far less time than could otherwise be obtained. The additional cost of separating the gravel into different sizes will be more than repaid by the wearing properties of the road. It is almost impossible to dump ordinary gravel on the road from a cart without having the larger stones roll to the outer edge of the heap, where they make a comparatively loose foundation, while the finer stuff in the center will be firmly compacted when it drops. As soon as the road made in this manner begins to wear, hollow places will show around the original heap; water will pass easily through between the large stones, and the road soon will go to pieces. A road so built will be much better if it be rolled with a steam-roller, but it can never be a really good road.

No town's outfit for road-building is complete without a roller of some kind, and all gravel roads will last longer, wear smoother, and be generally better if they are rolled.

Where there is any great amount of heavy travel, gravel does not constitute an economical road. The first cost is less, but the repairs necessary to keep the surface even and smooth will bring the annual cost to a much higher figure than would be the case if broken stone were used. The general principles of broken-stone roads are the same now as they were when Macadam first introduced a system in the construction of such roads. With modern machinery for breaking and rolling we can obtain better results in quicker time, and less care has to be exercised in watching the road as it hardens. Many roads are built in the United States with but four inches of broken stone, which have withstood the wear of several years; but the greatest care has to be used in every detail of the construction. These roads have been constructed for the most part on a foundation of sandy loam, but none that I am aware of on clay or heavy soil. The soil was first compacted by rolling, the crown conforming to that of the finished road way. On the prepared foundation the broken stone was laid about four-and-a-half inches thick. This was lightly rolled by passing the steam-roller about four times over it. Sand was then carefully spread over the surface as the roller passed back and forth until the interspaces were thoroughly filled to the tops of the stones. About one inch of broken-stone screenings which had passed through a half-inch screen were then laid on, watered, and thoroughly rolled until the surface became even and firm.

A second method is to spread the stone screenings on the broken stone without any sand; water, and roll as by the other method. A very thin spreading of fine gravel is at times laid on over the screenings to prevent the bond from being broken by dry weather. This is a good scheme if the road is not to be watered. Still another method of binding, which is much used with good results, is as follows: After the broken stone has been rolled, the surface is covered by a layer of screened hard-pan (mixture of sand, gravel, and clay) about one-quarter of an inch thick, and over this is spread stone screenings, which have passed through a half-inch screen. The steam-roller is passed over the surface until the finer material flushes to the surface in the shape of a fine paste, when the road can be thrown open to travel.

This is the whole secret of building a broken-stone road, when you have a natural soil that is suitable. I have referred to a sandy loamy soil as the only one on which four-inch roads have been successfully constructed. There can be found a great many old roads which have been gravelled year after year until they are solid as far as the foundation is concerned, but the gravel will not withstand the wear of wheels and the surface is usually very muddy. There are but few cases where this need be disturbed. As a rule the center of the roadway is flat and sufficiently low to allow of building up without first excavating. In this case the broken stone can be placed directly on top of the old roadway, however hard it may be, to a depth of about five to seven inches in the center and four to five inches at the gutters.

The stone should be rolled thoroughly before any "binder" be laid on, and watered and rolled again after spreading the "binder." Either of the methods of applying the binder before described can be safely used.

In case there is a clay or soggy soil the usual method is to excavate to a depth of about twelve inches. Build drains as referred to before, and connect them carefully with a watercourse or sewer. Large ledge stone should be laid with the point projecting upward and the base resting squarely on the ground, the stones to be placed as closely together as their shapes will permit. All the spaces between the large stones must be carefully filled in with wedge-shaped fragments, carefully rammed into place. The tops of such stones as project above the required line should be broken off by hammers. A thin layer of broken stone should then be laid on over the foundation stones and rolled. The broken-stone or metalling course is then to be applied in the same manner as already described for thin macadam roads.

The few main points to be remembered are as follows :

Get all water out of the foundation and keep all water from reaching it. Secure a foundation which will not permit the road metal to pass downward under any conditions of weather. Compact the metalling so that it cannot be further pressed down by the passage of teams over it. Fill the voids of the broken stone so as to prevent water from reaching the foundation soil. Use some material for a binder which will prevent the stone from being kicked out by the horses' feet and which will be so thin as not to injure the road surface when it wears out.

A good macadam road will wear out, like everything else. Its life will depend on the quality of the materials used and the amount of travel passing over it. Where proper care has been used in selecting and building, I have known roads to last fifteen to twenty years, with very slight repairs. At the end of that time they were thin and weak and needed rebuilding. The simplest method of repairing such a road is to pick the surface up, shape to the crown desired, resurface with broken stone to the correct grade, and roll and bind the same as on a new road.

While a steam-roller will perform the work better and at less cost, yet a horse-roller will compact a broken-stone road perfectly well. A two-ton ring roller is perhaps the best to use, as the weight is upborne by all the rings when the road is loose, and on only half of them as soon as the compacting begins, thus doubling the pressure per inch at the time most needed.

While we may not be able to regulate the grades on many of the old roads, we can regulate the widths. In most cases the width is far more than is demanded by the traffic. None of the excessively traveled way is kept in good order. In the older countries the finished roadway is made but fifteen to eighteen feet wide, and this is sufficient to accommodate all the travel. The shoulders can be finished out by the use of gravel or anything that comes most convenient so as to give a width of twenty-one feet. The crown or rise from the gutter to the center should not exceed one inch to the foot on a hill-side, and about half as much on level stretches. More than this compels the teams to keep in the center, and by continuous wear in one line to produce ruts.

The best rock for broken-stone roads is trap. It is hard, tough, and easily held in place. Schists, slates, soft limestone, and most of the gniesses are not good for road-building. With any amount of travel they quickly grind to powder to the destruction of the road. In most localities the field or bank stone will make fairly good roads, if the slates and schists are thrown out. They can be easily obtained and broken, and in most cases the land is much improved by their removal. It is good policy in setting up a crushing plant to bear in mind that each and every time the stone has to be handled it adds ten to fourteen cents a ton to the cost, and it should be set in such a manner as to save moving the stone as much as possible. If the crusher be set up so as to make it difficult for the teams to get in to load, then there will be a loss of time on the part of the teams which counts up quite rapidly and materially increases the cost of breaking the stone. In many cases it is necessary to shovel the stone away from the crusher in order to keep it clear, and this adds about ten to twelve cents per ton to the cost. A very good and at the same time cheap set-up can be had by placing the crusher on the side of a hill, accessible on one side to teams and over bins on the other. The bins should be sufficiently large to hold about one day's breaking and located to allow at least two teams to load at once. A still better arrangement than this is one in which the bins are set up high enough to allow a team to be loaded under them without shoveling.

The most economical method of setting a crusher is to place it low down, so the stone can be delivered directly to the jaws without moving, after they are once dropped. When the broken stones pass from the crusher, they should be delivered to an elevator, lifted about forty to sixty feet, dropped into a revolving screen, carried by chutes to bins for the different sizes, and loaded from the bottom of the bins by chutes or gates directly onto the carts. By such an arrangement the stone need not be handled from the time they leave the quarry to the time they are leveled off on the street.

While trap makes the best stone for macadamizing, yet it cannot at all times be obtained, and the cost of moving will be so great that a poorer grade of stone will have to be used. The hard syenites, felsites, conglomerates, and amygdaloids will make good work. Some of these will not roll down without covering with gravel,—particularly if a steam-roller be used. The roller will break off the sharp angles; the small fragments do not have any binding properties, and for this reason the binder must be placed on such stones before they are compacted.

On hills with a grade of more than eight or ten feet to the hundred it is difficult to place any material which will not wash during heavy rainfalls. In treating such hills I have covered the surface with hard-pan, giving it the proper crown. On this was spread about two inches of broken stone, the fragments of which varied from half an inch to one inch in diameter. After the first rain the hard-pan became very soft, and into this was pressed the stone until a firm solid mixture resulted which readily resisted the action of water and has worn but little in several years. Gravel will serve the purpose very nearly as well as the broken stone.

ELECTRICITY.

Conducted by Franklin L. Pope.

OME of the State legislatures are committing a grievous mistake in grant- ; charters indiscriminately to inter- ɔan electric railways, and giving them e free run of the public highways, and is without requiring them to pay any nchise tax for the privileges thus liber- y bestowed. This is a policy which no ate can afford to pursue, and one which sure to ultimately result in widespread saster. While most of the local horse ilroads which have been converted into ectric roads have proved very profitable vestments, it does not necessarily follow at tracks can be put down on every cross- untry road, and made to become ɔnanzas for the bondholders, merely be- use they are operated by electricity. It as by no means been satisfactorily demon- rated that for distances of five to ten iles, where hourly or half-hourly trips of small car are all that the traffic requires, lectricity possesses any economical advantage over steam or even over horse-power. he prevailing craze for covering the rural istricts with a network of electric railways s evidently being assiduously fostered by he manufacturers of electric apparatus in rder to enlarge the market for their wares, and so long as the public can be in- luced to purchase and pay for the bonds ssued to pay for these projects enterprise and prosperity will doubtless continue to go hand in hand. "The American public"—as the astute Mr. Gould once remarked—"are fond of bonds."

RECENT decisions of the Federal courts in patent cases indicate that the distinction between an invention, properly so-called, and a structural organization which is the result of a mere exercise of the ordinary skill of the mechanic or the engineer, which distinction at best is often liable to be somewhat hazy, is becoming lost altogether. We recollect no legal decision which has gone anything like so far in this direction as that recently promulgated by Judge Green at Trenton, relating to a patent on a system of circuits for electrical distribution for lighting and power purposes. In systems of pipes for the distribution of water and gas under pressure it has for years been a common expedient, whenever the consumption in a certain district had increased to such an extent as to reduce the pressure inconveniently, or to render it irregular, to lay a new main directly from the source of supply to the center of consumption in the district affected, and thus restore the pressure to the normal average. This combination of supply-mains with direct feeders is obviously applicable in precisely the same way and for the same purpose in electric systems, but this particular application has been made the subject of a patent, a thrifty idea which certainly never could have occurred to a gas-engineer, and it is this patent which has now been held to be valid by the decision referred to. Indeed the fundamental idea was shown not to have been novel even in electric distribution, so that the novelty of the patented invention is really limited to the use of a feeder of smaller capacity than the main. Hence it might be that the use of a conductor an inch thick might be no infringement, while, if one half an inch thick were substituted, it would constitute an infringement. This is but one of the multitude of inconsistencies and absurdities which are certain to arise in practice if the courts should hereafter lend their aid to the enforcement of the innumerable brood of patents which the government has of late years granted, covering what are neither more nor less than ordinary engineering expedients, devised in the first instance to overcome such difficulties as continually present themselves in every-day work. The same amount of invention is displayed by any man who, when he finds his water-supply insufficient, puts in a larger pipe. In fact, we know of one patent relating to electrical distribution, taken out by an electrical engineer of wide reputation, in which the "invention" claimed consists in making the sectional area of the conductors in different portions of the system proportionate to the volume of current they intended to carry. We shall doubtless hear of this last-named patent again ere long, in case the court of appeals should sustain the decision of Judge Green.

IT has been observed by Dr. Edward Hopkinson that it is well for the electrical engineer to be constrained from time to time to contemplate the proportion between the amount of energy available for his final purposes, as compared with the coal energy with which he starts. In the matter of transportation, for example, beginning with the familiar 12,000,000 foot-pounds of energy known to exist in a pound of coal, and making use of the most approved economical appliances now available in the art, we have a series of cumulative losses in the boiler, engine, generator, conductors, and motor, as well as in the dead weight of the vehicle, until we finally arrive at the energy expended upon the passenger himself, which we find to be approximately 133,000 foot-pounds, or a little more than 1 per cent. of the energy with which we set out. But even this is a more economical process than that of illumination by the incandescent lamp, in which the final energy rendered available does not exceed half of 1 per cent. Nothing that has been accomplished in the past in respect to the transformation of energy can for a moment be compared with the possibilities which the future holds in store for mankind.

THE employment of the magnetic separator enables a large portion of the native phosphorus to be eliminated from iron ore before it goes to the blast-furnace. This makes it possible to produce a grade of steel having a high percentage of carbon and an extremely low percentage of phosphorus. Such a steel, owing to its remarkable toughness, can be rolled at a lo temperature, and it therefore makes a ve superior quality of rails. Nearly 100,0 tons of such rails have been put into se vice on the principal railroads of t United States within the past three yea and it is stated on good authority that to the present time not one of them h been broken in the track by ordina usage.

THE electric elevated railroad of t World's Fair is 3.10 miles long, and has double track with loop terminals. Th are 10 stations, each of which is design so far as possible, to be approached in ea direction by an ascending grade, which expected to materially economize the c of operation. The principal electric ge rator is a 1 500-kilowatt multipolar, doubtedly the largest machine of the k in the country. The armature shaft is steel and weighs 65 tons. It is driven b 2000 horse-power cross-compound cond sing engine. In addition to this mon machine, there are three 500-kilow generators, and a smaller one of 2 kilowatts, with a corresponding equipm of engines and boilers. The entire eng and dynamo plant occupies a room feet by 87. The rolling stock consist eighteen trains of four cars each, the car in each train being equipped with motors. The nominal horse-power of motors is approximately 530 for each tr Each car is forty-seven feet long and s ninety-six passengers. The electrical ductor is a line of 60-pound steel r placed outside the traffic rails. The ro trip, including stops, is made in minutes, and the trains can be ru necessary, under two minutes headwa

AN electric plant has been erected a World's Fair for charging the storage-teries of the electric launches which a ply on the lagoons, having a capacity cient to charge simultaneously launches containing seventy-eight each. It is large enough to light a of 10,000 inhabitants. Another intere application of electricity to navigatio be a line of electrically-lighted buoys ling from the Exposition landing to foot of Van Buren street, which will e night navigation on the lake safe easy. Each buoy will carry an arc- t of 2000 nominal candle-power. Elec- ally-lighted towers 125 feet high will be placed on each of the piers, at the inals of the route.

DISCOVERY which promises to be of t importance in the arts has recently n made in connection with the electro- osition of copper and other metals. etofore these processes have been car- l on by immersing the metal intended eceive the deposit in an aqueous solu- of a salt of the metal to be deposited. e new process makes use of insoluble s of the various metals, which are re- ed to fine powder and mechanically ted with water. The mixture is applied the surface of the metal by means of a sh to the handle of which is attached electric conducting wire, so that the cess of deposition resembles that of ap- ing a coat of paint. Not only pure tals, but all sorts of alloys are applied coatings to other metals with the utmost ility by this process. The hull of an n ship, for example, may be painted over th a tough, adherent, and impervious ating of metallic copper, of any desired ickness. Experiments have been made ich indicate that this process may be ccessfully applied to the plating of alu- inum with silver or gold, a desideratum ich has long been sought for, but therto apparently in vain.

THE prospectus of the Chicago and St, ouis Electric Railroad Co. reads like a avesty on the story of the speculation hens projected by Euphemia, the young atron of Rudder Grange. Beginning ith ten hens, and allowing every reason- ble margin for losses, she expected to ave sixty hens at the end of the first year, 60 the second year, and so on, until at he end of five years the number should mount to 64,800, which, at 75 cents each, ould net her $48,600, a sum beside which he petty cost of a fence and a few chicken- oops was wholly unworthy of consideration. It has always been impossible for electrical men to look at the Chicago-St. Louis project seriously. We are informed by the prospectus that the undertaking is "in the main founded upon that which has actually been accomplished." We should say, rather, that the value of its stock was founded, like that of a certain telephone-syndicate which gathered in a goodly lot of shekels within the memory of many persons now living, "upon the future possibilities of electricity." The undertaking itself does not appear to be founded upon anything unless it is human credulity. The prospectus is a tissue of glaring absurdities, and in criticising it these seem so numerous that it is difficult to know where to begin. Yet as the slang phrase is, in these days "everything goes", if only it be labelled "electricity"; hence no one appears to see anything queer in the offer to sell a stock alleged to be certain to earn 29 per cent. per annum, at 60 per cent. of its par value.

IN a paper read before the London Society of Civil Engineers Dr. John Hopkinson gave some interesting statistical information respecting the operations of the South London underground electric railway. The engines average 230 indicated horse-power each, which is almost exactly one-half full load. The combined economical efficiency of the engines and dynamos is 78 per cent. at full, 70 per cent. at half-load, and 65 at quarter-load. The loss of energy in the feeders is exactly equal in value to the interest on the prime cost of the feeders, which is the condition of maximum economy. The coal consumed averages from 35 to 40 tons per day. Miles run in 1892, 214,417; passengers carried, 3,317,602. Cost of working generator station, including wages, renewals, and repairs, 4.59d per train mile, and equal to 1.56 per kilowatt. The locomotives weigh 10 tons, of which 6 tons is motor and the rest frame. It may be observed that the elevated railways in New York carry more passengers in thirty days than the South London line did during the whole year,—a fact which we mention merely to show the magnitude of the rapid-transit problem which New York, and in a lesser degree several other American cities, have pressing upon them for solution.

IN a recent paper on the commercial efficiency of transformer distribution M. Picou, a French engineer, points out that, while the alternate-current transformer, considered by itself, is an excellent piece of mechanism, its all-day efficiency, as ordinarily used, is comparatively low. Of the 5 per cent. of loss which occurs at full load, more than half is due to the iron, and is a fixed quantity at all loads, while on the other hand the loss in the copper varies as the square of the current. The conclusion is that the apparatus should be so arranged that the iron and copper losses for the average current shall be equal. It is certainly no easy matter to ascertain with certainty just where the losses take place in a system of alternating distribution through transformers, but that such losses may amount to an aggregate little short of appalling is shown by some of the experiences recently published in the technical journals in this country and abroad.

ONE of the largest paper-manufacturing concerns in the United States is putting in a plant for bleaching all the wood-pulp used by means of electricity.

A TWENTY-FIVE-FOOT motor freight-car has been placed on the electric street railway between Rockland and Camden, Maine, a distance of about ten miles. The car weighs 15 tons, and has a carrying capacity of 20,000 lbs., but can pull an ordinary freight car in addition if required. The trucks are fitted with four 50 h. p. motors, on account of the severity of the grades, which are such as to preclude the profitable extension of steam service over the route.

THE annual report of the street railway system of Albany shows that the gross earnings for 1892 are nearly double what they were for 1891, while the net earnings are $42,774 as against $23,328. This is mainly the result of the substitution of electric for animal power, in a locality in which the grades are exceptionally severe, and the travel at times very heavy.

A WRITER in *Industries* complains loudly of the want of a good book on telegraphy. He thinks there are an abundance of so-called "practical" manuals, but that what is lacking is a treatise on the theory of the subject. "We doubt," he says, "if any work on telegraphy exists in which, for example, an explanation of a relay is given which would enable an electrician to design one to work with a given current and a given internal resistance." We think that this complaint is ill-founded. There is more than one work, not alone in English, but in other languages which contains this, and much other information of the same general nature. Moreover, it must be remembered that for every person who needs to know how to design a piece of telegraphic apparatus there must necessarily be at least a thousand who need to be taught how to adjust and operate it to the best advantage. The great trouble is that the modern telegraphic employé does not care to study any scientific books at all, even the simplest and most elementary. We doubt if it would be possible to sell in this country to-day a hundred copies of a work treating solely on the theory of telegraphy, without reference to its practical aspects.

IN a lecture before the Society of Arts in London Professor George Forbes said that no system of electrical distribution could be considered as final which did not provide for electric motive-power, illumination, and storage. A combination of the various systems in use seemed likely to be evolved, combining the advantages of high-pressure alternating transmission with low-pressure continuous current distribution, suitable both for storage and for motive power.

THE British householder seems to be a queer bird. The London *Electrical Review* remarks that the electric-lighting companies which have undertaken to exploit the residential districts have been far less successful than was anticipated. The eholder had his house wired and the s installed, and then it appeared that height of his ambition was to keep lectric-light bills as small or smaller his gas-bills. Consequently he has l at home every evening, and devoted ime to following the servants around ake sure that all the lights were turned s soon as they were no longer needed. was by no means satisfactory from the t of view of the central-station man's curve, and so the companies, it seems, holding on, and waiting with as much ence as may be for the householder to tired, so as to permit the load curve ise.

HE silly assertion is made in a leading ncial journal that the failure of the stor- -battery to secure adoption in this ntry is due to the opposition of the neral Electric and other large elec- al companies, on the ground that general introduction will render anti- ated and worthless an enormous elec- al plant, constructed at high cost. It charged that these great companies ss no opportunity to purchase all the rage-battery patents that make their pearance, not for the purpose of afford- g the public increased facilities, but with view of perpetuating the hated trolley stem. Such a policy is animadverted on in severe terms, as being "penny wise d pound foolish." We should say it was.

THE Edison Electric Illuminating Com- any of New York report the total in- allation of incandescent and arc lamps nd motors, up to January 31, as equiva- nt to 202,000 16 candle-power lamps.

A NOTABLE telegraphic feat has been erformed by the Direct Cable Co., in ransmitting the result of the Oxford- ambridge boat race to this country in hirteen seconds, this being the actual time ccupied in obtaining the news at the ourse, forwarding it through London and cross the Atlantic, and delivering it in he office of the United Press in New York. The cable service has been brought to an admirable state of efficiency on all the transatlantic lines, and it is seldom that even an ordinary commercial message occupies more than ten minutes in transit.

THE great electric-power transmission-plant at Pomona, Cal., heretofore mentioned in these notes as in course of construction, is now in successful operation. The generators are driven by direct-coupled Pelton wheels, under a head of over 400 feet at 600 revolutions per minute, and each generator delivers alternating current at a pressure of 1000 volts to a bank of transformers, by which the initial pressure of the line is raised to 10,000 volts. Circuits of bare copper wire, carried on special insulators, extend to the towns of Pomona and San Bernardino, the latter being twenty-eight miles distant, where the power is being utilized for lighting and other purposes.

EXPERIMENTS are now in progress looking to the application of the trolley system to the propulsion of boats on the Erie canal, referred to in these notes some months ago. The locality selected for the first trial is the section between Albany and Troy. There is no reason to doubt the entire feasibility of the plan, if its execution is placed in the hands of competent persons.

IN another part of this magazine is given at length an account of Professor Gray's telautograph, which has been successfully exhibited in New York during the last month. It would seem somewhat problematical whether the want which this apparatus is designed to supply really exists to an extent which will make it profitable to its ingenious inventor. At first sight the employment of such a system would appear comparable with a proposition to abandon the typewriter for business purposes and go back to the time-honored pen. But it is nevertheless not difficult to imagine cases in which the possibility of the reproduction of a holographic communication at a distance might be of almost inestimable service.

MECHANICS

Conducted by Leicester Allen.

PERHAPS nothing indicates the enormous strides mechanical progress is making throughout the world so much as the almost complete revolution effected in methods and means of naval warfare during the last three decades. Nowhere has the advance been more conspicuous and overmastering than in the United States. Comparatively few, even of the best informed classes of our citizens, have realized the extent of this change wrought in the brief period named, and particularly the fact that the greater part of it has been brought about during the last eight years, a period of almost profound peace with all the world. It has been said that the history of war is also the history of civilization. It might be said with as much truth as usually inheres in generalizations of this kind that the history of naval progress is the history of mechanical progress.

If in writing this history an author should seek to divide it into epochs, it could scarcely be otherwise than that the last and grandest epoch of all should have its beginning placed contemporaneously with the first conversion of the reciprocation of a piston in a steam-cylinder into the continuous rotary motion of a crank, through the auxiliary appliance known as the fly-wheel. From this union sprang modern mechanical possibilities.

The complimentary dinner given to the retiring Secretary of the Navy, the Hon. Benjamin F. Tracy, by the Hamilton Club in Brooklyn, on the evening of March 16, was, on two accounts, a remarkable occasion. First, there were present the two great secretaries under whose administrations the naval progress of the past eight years in the United States has been accomplished, one being the Hon. William C. Whitney, his predecessor in the office. Second, the extent of this progress, as set forth in the speeches of these two able men, was never before so comprehensibl and forcibly presented to the Americ public. From these speeches, especial that of Mr. Tracy (which, by the way, d full justice to the advances made und Mr. Whitney), it may be learned at wh a rapid pace our navy is overtaking oth famous navies. When Mr. Tracy ma his first report in December, 1889, stated "that, when all the ships which h been authorized up to that time sho have been completed, the United Sta would still rank as the twelfth na power." But in the speech alluded to said:

> But such is not the condition of the Uni States to-day. When the ships now in course of construction are completed, we rank as the fifth naval power, surpassed only England, France, Russia, and Italy. We s have passed both Spain and Germany, and once more take rank among the naval power the world.
>
> I am aware that this is the first public nouncement of our superiority to Germany. the statement is made not unadvisedly, but careful comparison of the two navies shi ship. From such comparison it appears with the ships which constitute the figh force of the two governments the U States can throw in any one direction, single discharge, 31,000 pounds of metal ag 25,000 pounds by Germany. In speed efficiency our cruisers far surpass those o German navy.

In four years, therefore, the navy of United States has advanced from twelfth to the fifth rank among the na of the world; and as this advance has entirely dependent upon mechanical struction *in our own country*, it indica state of the mechanic arts that places a nation, in the very van of progress. industries have also been developed brought into perfect working order a result of the effort to strengthen eans of naval defense. Again Mr. Tracy ays:

> The great progress we have made has been chieved not so much by the number of ships we ave built as by their greater power and efficacy. hip for ship, there is nothing in the world that s superior to the ships of recent American deign and construction. It is not only in the type nd construction of ships that progress is to be oted, but in certain auxiliaries that go to make p a naval force.
>
> Four years ago we had ships which had been constructed for the nse of torpedoes, but we had no torpedoes nor had we any means of producing them; but to-day Brooklyn is producing as good torpedoes as are manufactured anywhere in the world. The plant is not yet two years old, bnt the success of the enterprise is already assured.
>
> Bnt the greatest progress made in any one direction has undoubtedly been In the prodnction of armor. For twenty years it has been a conceded fact that the gun could beat the armor, hut we have reversed this and hare succeeded in producing an armor-plate that can beat the gun. The nickel-steel armor-plate Harveyized cannot be pierced. Every projectile that has been fired against it has been crushed into amall pieces. You may break it, but no projectile can get through it.
>
> The production of this armor has made the armor now on all English ships so inferior as to be practically worthless.
>
> The nickel-steel Harveyized armor is an American prodnction which every naval power in Europe is now preparing to adopt. The production of this armor is undouhtedly the most important event connected with my admlnistration, and for which it will be the longest remembered.

SPEAKING of fly-wheels, there have of late been numerous instances of bursting fly-wheels; and this class of accidents appears to be on the increase. The conditions of working have been changed, particularly in the matter of running speed. Large fly-wheels—diameters fifteen feet and upward—are now run at peripheral speeds of from 80 to 120 feet per second, at which velocity the centrifugal strains are very great. Frequently it is found, when fly-wheels burst, that flaws in the castings have existed, originating in the foundry where they were made. Such flaws indicate that methods of founding need looking into with reference to the improvement of fly-wheels. As any desirable degree of strength is attainable in a built-up wheel, it might be advisable to abandon former methods in favor of some new construction for fly-wheels of large diameter, running at high peripheral velocities.

ALUMINUM is gaining a place among industrial metals. Lately there has appeared in the show-windows of fancy goods stores a variety of articles made from aluminum. In appearance these goods are little, if any, inferior to silver articles, and they are less liable to tarnish from the action of sulphur gases. The metal is well adapted for numerous things in common use, such as pocket match-safes, cigar-cases, pencil-cases, and even watchcases. It will be more and more used for these and other purposes as time advances. One of the disabilities that has prevented its more rapid introduction into various industries has been the lack of suitable solders for joining it after it has been reduced to required forms. Among others who have been studying the applicability of different solders for aluminum working is M. J. Novel, who has recently published several recipes for white solders suitable for the pure metal, and yellow solders for aluminum bronze. Some recipes for white solders are as follows: (*a*) Pure tin 1000 parts and lead 50 parts; melts at 536° to 572° F. (*b*) Pure tin 1000 parts; pure zinc 50 parts; melts at 536° to 612° F. The last-named solder is recommended for jewelry and other fancy articles. Light yellow solders are: (*a*) Tin 1000 parts; copper 10 to 15 parts; melts at 662° to 842° F., according to amount of copper used, and makes a much stronger union than the white solders. (*b*) Tin 1000 parts; nickel 10 to 15 parts; melting-point, 662° F. to 842° F. A good, strong union can be made with this solder. A deeper yellow alloy for soldering aluminum bronze consists of tin 900 parts, copper 100 parts, and 2 to 3 parts bismuth. The shade of yellow can be varied by varying the amount of copper between the limits given. Altering the proportion of bismuth within the limits named varies the melting-point so that the solder is suitable for use not only with aluminum bronze, but for joining aluminum to copper, brass, zinc, iron, or nickel.

AMONG the many innovations in mechanical operations and methods that electrical engineering has opened a way for that of melting and casting metals in exhausted chambers through the aid of the electric current is one of the most curious and interesting. The method is called the Taussig process, after its inventor, Professor Taussig. A recent exhibition of this process by its inventor, in the casting of a model propeller, is described in *Industries* (London), from which the following description is condensed:

The iron furnace consisted of a rectangular vessel 6 feet by 3 feet by 3 feet. Two electrodes, apparently of wrought iron, were placed upright inside the furnace, so that their surfaces, of 8 inches by 4 inches, faced the arc-shaped piece of iron which was to be fused; a channel of clay served the purpose of conducting the fused metal from its clay melting bed into the empty clay mold placed at a lower altitude in the otherwise empty iron furnace. The wires connecting the flat metal electrodes with the generating machinery were already in position, as was also the exhaust pipe connecting the furnace with a steam air pump of about 20 horse-power, which also drove the dynamos. The 30 lbs. of pig-iron in the clay bed having been placed parallel with, but a few inches in front of, the flat electrodes, the cover of the oven was swung on; the necessary exclusion of external air being effected by india-rubber pads fastened to the furnace cover. The cover being fastened down, and the pump set working, the currents were switched on at the same moment. The indicator on the exhaust-pump soon showed an exhaustion of 92 per cent. of air. The electric indicator showed respectively 2500 to 3000 amperes and 2 to 2½ volts. The gradual approach from red to white heat could be followed from the eyelets in the furnace. Fusion was obtained in 8 minutes, the indicators showing great uneasiness until the resistance had been reduced to nil by the current being allowed to pass freely through the fused metal. In 14 minutes the furnace was opened, and a minute or two later the clay was chipped off and the perfect cast of a propeller was exposed to view.

Just how far-reaching in its effects upon mechanical operations this innovation may prove it would be rash to predict; but to an imaginative mind it appears to open an almost inexhaustible vista of possibilities.

IN this department recent mention has been made of the extension of the range of temperatures, both positive and negative, lately found possible to be maintained, and of the extension of knowledge of the physical and chemical qualities of materials this is likely to effect. Mention was also made that at the low temperatures now attainable common air condenses to a liquid under ordinary atmospheric pressure. Since the previous writing alluded to Professor Dewar has communicated to the Royal Society the announcement that he has succeeded in congealing air to a true solid form. The details of these remarkable experiments of Professor Dewar would be out of place in this department, although they are of intense interest in themselves. The opinion expressed in the former mention of investigation lying in the direction of low temperatures, that the metallic or non-metallic character of hydrogen might ultimately be determined by reducing it to a solid state, seems now all the more likely to be soon confirmed. The long suspected part that this substance plays in metallurgic phenomena, if once definitely ascertained, might prove of immense value in all mechanic arts wherein metals are the principal materials employed.

PROFESSOR S. P. LANGLEY'S steam-engine, designed for the flying-machine upon which he has been so arduously working for about two years, seems a paragon of scientific construction for the attainment of a specific purpose. That purpose was to obtain the lightest posble working steam-engine in propor- on to power developed. The minimum f weight seems to have been obtained, owever, only at a maximum of cost. These points of Professor Langley's engine re referred to in Professor Thurston's ex- ellent articles on "Progress in Steam-Engineering," the first of which appears in he present number of this magazine. The most interesting of the innovations in this machine (doubtless to become historical in the literature of aero-navigation, to which Professor Langley has been one of the most important contributors) is the substitution of a hydrocarbon, probably naphtha, for water in the boilers; the vapor of this liquid to be used in the engine cylinders in the same way as steam is used in ordinary steam-engines. The boilers are of copper, and the fuel is said to be gasoline.

As to the flying-machine itself, it may or may not meet Professor Langley's expectations; but those who have hastened to predict a failure are reminded that the experimenter is a man of no ordinary type. With the highest scientific attainments, he possesses great skill in practical construction, and is the last man one would expect to deceive himself in a matter of this kind. His writings upon the subject of mechanical flight evince a depth of insight into the principles involved scarcely equaled by any other investigator, and previous work in astronomical observation has disciplined his mind to minute scrutiny of all that relates to any line of investigation he may enter upon.

The machine is described as being fish-shaped, with crescent-shaped aero-planes, the material of which is a groundwork of steel covered with silk. Several small propellers will be used to drive it, and the engine driving these propellers is stated to develop one horse-power for five pounds weight in the motor, a result hitherto unprecedented. Were there nothing else in Professor Langley's work to render him famous, this achievement is enough to arrest the attention of the mechanical world.

A DREDGING-MACHINE of such proportions and capacity as undoubtedly entitle it to be considered the largest and most powerful machine of its kind in the world has been recently launched at Barrow, England, at the shipbuilding yard of the Naval Construction and Armaments Co. It is a twin-screw, hopper and sand-pump dredger and has been christened *Brancker*. It is to be used in removing the Mersey bar so that the steamers of the largest tonnage may enter that river at low tide. The machine is claimed to be able to fill the *Brancker's* hoppers to their full capacity, 3000 tons of sand, to proceed to the dumping ground, discharge the load, and return to the bar all within a single hour. For a day of ten hours its capacity is therefore 30,000 tons, an amount of work probably never before performed by any single dredger of this or any other type.

THE great clock of St. Paul's church in London must be a remarkable piece of mechanism. The *City Press* (London) complains bitterly of the vandalism that has led to the removal of this clock and the substitution of a modern tower-clock for it. It says the old clock, "which was put up by Langley Bradley in 1708, is in splendid condition and might to all appearance go on for another two centuries without failing to bear accurate record of the passing time. It is a grand old clock, remarkable for the magnitude of its wheels and the fineness of its works. It cost £300 to build. Its two dial plates are 51 feet in circumference, and the hour numerals 2 feet 2½ inches in height. The minute hands are 9 feet 8 inches long and weigh 75 pounds each, and the hour hands are 5 feet 9 inches long and weigh 44 pounds each. The pendulum is 16 feet long. It is an eight-day clock, striking the hour on the great bell, which is suspended about 40 feet from the floor. The head of the hammer weighs 145 pounds and the clapper 180 pounds." Think of a machine like this running night and day for two hundred years and still in fine working order. One would suppose the customary reverence for ancient things in England might save the degradation that awaits this masterpiece of the horologic art.

around which cluster so many historical, poetical, and literary associations.

THE United States timber-tests, of which mention was made in this department at the time they were initiated, and from which much valuable information was expected to be obtained, appear to be embarrassed by the neglect of Congress to make suitable appropriations for carrying them out. The following communication shows the exact status of the matter at the present time:

Mechanical Editor ENGINEERING MAGAZINE:

Although all the leading railroad engineers, architects, professors of engineering, and others interested in the timber-tests had flooded with hundreds of letters their representatives and senators and the committee on manufacturing in whose hands the special appropriation for the United States timber-test work was pigeon-holed, neither the committee nor the house paid any attention to this expression of public interest. The senate, however, realized that there was value in the work and sincerity in its endorsers, and increased the appropriations for the Forestry Division by $8000; that is, 20 per cent. of the amount asked and considered by those in charge as necessary to continue the work on a proper business basis. Under the circumstances the testing will be discontinued until after July, when the new appropriations become available, and then proceed at the slow pace which Congress has set.

Although the result of the efforts of those who took active interest in securing appropriations for the work were not crowned with that success which they deserved, this is the only proper method of influencing legislation, and those interested in the investigation should not fail to move again when the new Congress assembles.

The first complication of test results is now in the hands of the printer and will probably be issued within six or eight weeks as "Bulletin 8, Timber Physics, Part II." It will contain the results obtained on longleaf pine, and will especially discuss in detail the results of tests and examinations of bled and unbled timber, results which in themselves justify the expenditure by the government of money on such work.

The Forestry Division will exhibit the methods pursued in this work at the World's Fair, which will be of interest, since nowhere in the world has such a comprehensive and systematic investigation of timbers ever been devised. The working plans for a similar undertaking by the Prussian government have only just been perfected.

Another exhibit of interest to railroad engineers and those interested in reducing forest waste will be a collection of the most approved types of metal railroad ties.

B. E. FERNOW.

Regarding these tests as among the most important experimental work yet undertaken under government auspices, it is hoped that such a pressure will be brought to bear upon the next Congress as to secure all needed appropriations for the vigorous and thorough prosecution of the work.

IT is said that Herr Krupp, the famous manufacturer of heavy guns, is carrying out a series of experiments on an entirely new line, the use of mixed coal-dust and atmospheric air in motor engines to develop mechanical power. Such mixtures burn with explosive violence, and produce in an engine cylinder an effect entirely analogous to similar explosions in gas-engines. The production of ashes by the combustion is a difficulty which has to be overcome; but it is said that the distinguished experimentalist expresses entire confidence that the removal of the ashes can be practically accomplished, and that, while in the use of coal for generating steam only a small part of the heat can be converted into power, the direct use of fuel in an engine cylinder may result in the utilization of perhaps 80 per cent. of the mechanical equivalent of the heat. It would seem that the prevention of cylinder and valve cutting from the pressure of gritty matter always present in coal ashes would be a most difficult problem to solve in carrying out the proposed scheme, and that anything like good lubrication of the working parts in and connected directly with the cylinder would scarcely be possible. If Herr Krupp should succeed in mastering these and other practical difficulties that will readily suggest themselves to a mechanical mind, he will add much to the honor in which, as a mechanical engineer, inventor, and business organizer, his name is now held throughout the world.

A REVOLVING grand-stand for race-courses is among the newest of mechanical inventions; and, as it caters to a wide-spread passion for a sport numbering a large proportion of the public among its devotees, it seems likely to come into popular use. It enables its occupants to see accurately and successively all parts of a race-course, and, without change of position, to keep the horses in view in all parts of the race. The stand is made to float on the surface of water contained in a circular basin, and is slowly turned by mechanical power under control of an operator, who thus can make it face the horses from start to finish. Any one who has experienced the uneasy interval of suspense during the time when the horses in a race are out of view—generally somewhat more than half the circuit—can appreciate the additional pleasure and relief this invention might afford. There appears to be no limit of size beyond which such a stand would become impracticable, since its buoyant power can always be made proportional to its seating capacity; and its turning, no matter how large, can be regulated with facility. The stand can be so placed with reference to the wires that the most interesting events of the race, the start and the finish, can be closely viewed. When the future historian shall write the story of engineering as applied to amusements in the twentieth century, this device will probably be one of the things to be recorded; and when so many years have been snowed upon the record as to render it classical, as are existing accounts of ancient Greek games and Roman chariot races, like the ruins of the Colosseum it may make an attractive picture in text-books of a future age.

A COMPARISON of forced and natural draught for marine boilers has been made between the steamships *Adirondack* and *Alene* in the West India trade, by their owners. A gain in economy of 20 per cent. is claimed for the forced draught. *The Engineer* (London), with reference to these and other similar tests, says that two years ago Messrs. Denny and Co. built two steamers for the British India Steam Navigation Co., the *Vadala* and *Virawa*. These ships are alike in all particulars except boilers. The *Vadala* has two double-ender boilers with eight furnaces, three feet seven inches in diameter. The *Virawa* has two single-enders with Howden's forced draught, and four furnaces three feet seven inches in diameter. Both have been working in the eastern seas for two years. In making comparisons of economy great precautions have been taken, even to changing engineers from one ship to the other. Messrs. Denny & Co. now report that "the *Virawa* performs the same work as the *Vadala* on fifteen per cent. less fuel. The coal used is, to a large extent, Bengal coal. This comparison, it will be noticed, is giving the natural draught the advantage in large boiler power, as the *Vadala* has eight furnaces 3′ 7″ diameter against the *Virawa's* four 3′ 6″ furnaces 3′ 6″ diameter." Besides greater economy, the *Virawa* has maintained a higher average of speed than the *Vadala*. With reference to a voyage to the West Indies in the *Alene*, one of her owners is stated in the *The Engineer* to have reported that he considered forced draught as indispensable for their trade, as by it a steady speed of twelve knots can be maintained with ease under all conditions of atmosphere, and that, instead of men sweltering in the stoke-holds in sultry weather, trying to maintain steam as in natural draught steamers, the stoke-holds were the coolest part of the ship. He reported, also, that "there was not a particle of dust or soot on the deck of the ship," a condition of things the very opposite from what he had been led to expect from the use of forced draught.

ARCHITECTURE.

Conducted by Barr Ferree.

THE work of Frenchifying American architecture goes merrily on. Within the past year one eminent professor of this art was scarcely dead, and certainly not buried, before urgent calls were sent to Paris for a successor. Every year crowds of draftsmen flock to Paris, spend a year or so in the Ecole des Beaux-Arts and return to their native land deluged in a veritable bath of Parisian atmosphere and art. No one has yet attempted, we believe, the full ten years' course, but the first student who shall do so must be near at hand. Our architectural schools and professors lose no time in teaching, as best they may, the Parisian system, and then sending their students abroad in order that they may really learn something. If a more significant commentary on this strange fascination were needed it may be found in the fact that none of the leaders in this movement have so much as set foot in America, and all the tremendous energy that our students are expending in this direction is so much vitality wasted. Architecture has only really flourished when it has responded to the conditions under which it has been produced. It has been reserved for the American people, in the last decade of the nineteenth century, to undertake the reversal of a method in use since the world began, and develop an architecture based, not upon the essentials of the problems, not upon the conditions and circumstances under which buildings were produced, but upon the ideas of a body of foreign architects who have reduced the art to a science and know nothing out of their academic vocabulary. It is quite to be expected that the Americans who have studied at the Ecole des Beaux-Arts should wish to keep its memory green by the formation of a club. This is quite their right; but when they go beyond this and undertake to urge other draftsmen to study abroad they invite general criticism. Such a club has just been organized in New York, and marks a fresh stage in the amazing French enthusiasm which characterizes American cultured architecture. As a sign of the times it is interesting; as an indication of the possible future of American architecture it is expressive of the deepest gloom.

We would not be misunderstood. We are quite aware of the merits of the Ecole des Beaux-Arts. We admit that its American students have accomplished great things for American architecture, but this has been because the fire of architectural genius burned within them, not simply because they passed through the French architectural mill. Architectural draftsmen in America are not apt to consider this, nor are they willing to take into account the manifold demerits and disadvantages of the French system. Paradoxical as it may seem, it is nevertheless a fact that though Paris possesses the foremost architectural school in the world, French architecture is of all others the most frozen, the most academic, the most stationary. The magnificent *projets* with which the time of its students is largely occupied are pure fancy sketches, never erected and never intended to be erected, unless, perchance, some foreign country holds a World's Fair and a particularly-striking design is pressed into service for some strange purpose. And in this crystalization of architecture—for such is the logical result of the French system—lies the danger, the unadaptibility, and the absurdity of its employment in America. American architectural conditions are very new. Never before in the history of the art were conditions similar to those we meet every day presented for solution. Not only are our conditions new, but they are varied and difficult. Under such circumstances any form of architectural work or practice that tends towards crystalization should be voided at all hazards. Neither French rchitecture nor American architecture as yet reached a point where it can afford o stand still and invite the rest of the world to inspect its excellencies. The French doubtless think they can do this, and may, perhaps, be left to settle their own position, but Americans cannot afford o be thus blindly led. What would be said if any one to-day were to start to each Egyptian architecture to American draftsmen? Or East Indian or Central American architecture? The most secure and deeply-padded cell of an insane asylum would scarcely be considered safe for such a person. Almost as absurd is the conception—if one can conceive it—of the Greeks practicing Egyptian architecture and seeking to reproduce its forms. We know indeed that the Greeks obtained many forms from Egypt, but they gave up the study and reproduction of Egyptian architecture in a prehistoric age. Yet in this enlightened time we find very intelligent men imagining that they are perching themselves upon the loftiest pinnacle of architectural discernment in recommending Americans to go to Paris to learn architecture. It is a foreign transplation, pure and simple, and cannot be called anything else. The danger of this foreign study is that our architects cannot break themselves from it. The forms are so thoroughly part of the system that one cannot be learned without the other. And hence the origin of many strange applications of French ideas to American conditions.

NEVER has there been such a sharpening of lead pencils, such a getting out of drawing-boards and of drawing-paper, such a cleaning of instruments and drafting preparations generally, as during the past month. Our students from the Ecole des Beaux-Arts, wearied with designing $8000 and $10,000 cottages and houses, after a training in the most elaborate architectural schemes the human mind has conceived, have at last found something worthy of their genius and their abilities. New York has instituted a competition for a new City Hall; all the young men—and some not young as well—recognize in this a direct interposition of Providence, in providing a way out of their present state of mediocrity to that glorious and perilous height on which Fame rests, ever holding out crowns of laurel wreath for the fortunate individuals who climb up to her. And the sensation is not a wrong one. It is a great opportunity, and no one can be censured for taking advantage of it. In many respects it is the greatest opportunity yet offered to architects in America. No American city has a municipal building which can in any sense be termed first-class. Many of them are old structures, built before the present revival of architecture and at a time in which American architects were quite unfitted, either by training or by experience, to undertake great and lasting work. Even the most recent structures of this sort are wanting in the element of greatness, an indispensable adjunct of grand architecture, though a number of them possess many admirable merits. The New York competition is, therefore, especially welcome. Not only is that city the richest in America, but its emphatically metropolitan character gives the proposed new building unusual significance. It is true that the sum at present designated as the total cost,—$4,000,000,—is not large, all things considered, but in a fair and just competition, such as this promises to be, there is every reason to look for an important and notable building. It is true that the Press of New York does not think so; a new municipal building in the City Hall park has been a possible bugbear before its eyes for many years past, and it is not likely to look with favor upon any structure which will deprive its own buildings of their present extraordinary amount of light and air, and thus, in a measure, operate as a disturbing element in the large incomes derived from that source. But as the new structure is not to advance beyond the line of the present building, the People—newspaper word for tramps, bums, and similar worthy citizens—will still have all the space they have at present for rest and relaxation. And in its unselfish and public-spirited advocacy of the rights of the People the Press will have this balm for its injured feelings. It certainly is not to be despised.

In the Hotel Waldorf New York has certainly the most magnificent hotel in the world, and a building that surpasses many European palaces in the richness of its appointments. Certainly no other building in this country, public or private, surpasses it in magnificence of appointments, in elaborateness of decoration, in costly splendor of detail. It marks an epoch in American life not only in the extent in which the decorative arts have been pressed into service, but in expressing the luxury and magnificence which American people are beginning to require on every occasion and under every circumstance. Admirably planned, with a wise and economic employment of space, given a monumental and effective architectural exterior, provided with the most improved internal fittings and conveniences, its most striking feature has been the employment of artists of the first rank on the decorations of the public apartments on a scale not hitherto attempted in New York, with a sumptuousness of result and a disregard of expense almost bewildering. Of these the chief are the public dining-room on the Fifth avenue, with a ceiling decorated with three panels by Mr. Frederic Crowninshield; the "Marie Antoinette" room, a small parlor or reception-room, with a ceiling by Mr. Will H. Low; and the ballroom, to the ceiling of which Mr. Low again contributes three ceiling panels. The gentlemen's café and the conservatory, also on this floor, are noteworthy apartments, though neither is as elaborately decorated nor as successful as the larger rooms. It is a significant indication of the tendency of American hotel life that the large office or general assembly room, and the suites of public parlors, once invariable features of American hotels, are altogether wanting. As an offset to this the building is amply provided with suites of apartments, many of which have been decorated and furnished in distinctive styles, and form an unmatched series of private rooms. Notwithstanding the generally costly effect of these rooms, they have a rather unpleasant sensation of crowding, the sleeping-rooms being small and the greater space being given to the parlors. Doubtless from the hotel-keeper's standpoint this is just as it should be, but the impression is deeper from the apparent disregard of expense in the furniture and fittings. This is especially notable in the "state apartments"—a richly decorated and furnished suite set apart expressly for great personages only—though its drawing-room is of unusual size. The hotel is so large, also, that one rather looks for large rooms in its immense bulk, and this in itself may account for the impression made by the rooms. But it is to the public apartments on the ground floor to which the visitor's attention is most apt to be drawn, and in which he will find the greatest satisfaction. Opportunities for mural decoration on a large scale have been comparatively rare in this country, and the advantages offered in the Waldorf are the more striking because the work has been done by American artists. The success with which this has been accomplished marks a new era in American decoration which cannot but bear good and effective results in the near future From this standpoint the Waldorf acquires an importance to which as a mer hotel it would not be entitled. It is easil one of the most notable public building in New York, and is a monument tha reflects lasting credit upon all concerne in its production.

One of the most important measure now before the New York legislature is uniform building law for the cities in th interior of the State, graded in proportio to their population, and embracing a cities save New York and Brooklyn. has been prepared by a commission, which Mr. William J. Fryer, the author the New York city building-law, and wit out question the greatest living authori on the subject, is chairman. Apart fro its local significance this law is noteworth in marking a line of action that must, b fore long, be followed by all the State Although drawn with the greatest car and by a body of representative and cap men, the city of Buffalo has risen in position to it. And this, not because it ds the law faulty, but because its city arter, unlike the charter of other New rk cities, expressly confers upon it the ht to draft and ordain its own building- r. Unfortunately this privilege has not en properly availed of, for Buffalo is ovided with a deficient and unsuitable r of home manufacture which it is now oposed to supplant by a more compre- nsive State law. The question, from the iffalo standpoint, is one wholly of local ide, yet the city now presents the extra- dinary spectacle of seeking to refuse a od thing because it has something bad.

an interesting letter to the Buffalo *urier* Mr. Fryer, in recounting some of e more glaring errors and omissions in e Buffalo local law, pithily points out the reat importance of the building-law to ery community. It is, indeed, as he ys, of national importance, and is greater an the tariff question, the silver ques- on, the temperance question, or any issue hich divides political parties. Yet there re few subjects so little understood or ppreciated. Our newspapers, magazines, nd reviews are filled with political discus- ions, assumed to be of vital importance, et the more pressing matters of life and leath, of health and wealth, all of which re directly concerned in a wise and thor- ough building-law, are confined to a few echnical journals, or only studied by a few pecialists, like Mr. Fryer, who have devoted their lives to the thankless task of trying to get people to build safely and well. Nothing could exceed the horror felt and expressed when some great building catastrophe happens, entailing a great loss of life and money, and the public clamor for the swift punishment of all concerned is of the most active and commendable nature. But there are many grave defects in building, unguided by proper supervision and restriction, of which the public at large never hears, though human life is constantly jeopardized by it. It is to improve these conditions, and to help to save the present enormous and totally unnecessary losses from fire, that the proposed New York State law has been drafted. Movements such as these should have the support of all good citizens, irrespective of local pride or privileges. It is a subject that concerns not Buffalo alone, nor even New York State alone, but the country at large.

THERE has never been a more complete admission of the failure of competitions than is contained in the instructions to architects for the new city hall in New York. If there is any merit in architectural competitions, it must be that they afford the surest and best way for obtaining the best results. This being so, it is certainly a reasonable proposition that the man who gains the work is the very best individual to carry it out. His work has been examined and criticised and compared with the work of other men studying the same problem and looking for the same result. If the jurors are suited to their task, the successful competitor should, by the theory of competitions, be thoroughly well fitted for his work. There has never been a competition in America which will attract more attention than the New York city-hall competition; few programs have been prepared with greater care or by more distinguished authorities; yet these very same authorities have decreed it as one of the essentials that, if the author of the selected design be "an unsuitable person" for so important a work, the board of commissioners shall have the right to associate some other architect with him. Could anything be more significant of the real nature of competitions? Had these gentlemen said the competition was to be an exercise in drawing, and further added that the man who sent in the best-looking set of plans would get the building, they could not have more distinctly admitted the real nature of the whole matter. The point to be considered is not the wisdom of the provision, but simply its force as a commentary from the most exalted sources on the real value of competitions. If architecture is an art by which the young men and boys who throng the architects' offices can, by the mere exercise of their pencils, place themselves on a level with those who should be their masters, obviously our whole architectural system needs to be reversed. But, after all, it may be questioned if this provision is needed. Great municipal buildings are not designed by undergraduates in our colleges and offices, nor is the technical skill necessary to produce a passable set of drawings to be obtained without many years of arduous study and long experience in handling difficult problems. The competition will undoubtedly afford a great opportunity for many young men, and many of them will avail themselves of it, but their enthusiasm may well be dampened by the fear lest the board of commissioners, in the exercise of the wisdom requisite for the fulfilling of their task, designates them by the horrid word "unsuitable."

SOME large fires in so-called fire-proof buildings during the past month have attracted unusual attention, not only from their own importance, but because they have presented almost the first serious test of modern methods of construction. The most notable instances were the Boston fire (March 11) and the fire in the Temple Court annex in New York city. In the two cases the conditions differed, though both fires originated in what are called fire-proof structures. In Boston the fire started in a store filled with an immense stock of inflammable material. A terrific heat was very soon generated, and it was absolutely impossible for any form of construction to resist it. In New York the fire was confined to an office-building, and was fed by the furniture and interior woodwork. This, as has so frequently been the case, had not been reduced to the smallest minimum. This is not the first time this lesson has been taught, nor is it likely to be the last. Yet with an example such as this builders and owners must recognize the folly of erecting costly edifices in a manner which will enable them to burn down at the first opportunity. Until some enterprising genius puts his mind down to devising a substitute for wood, human affairs must be conducted with more or less of this material. Experience has shown that safety lies only in using it in the smallest possible quantity. A modern office-building is so complex a structure, the electr
cal devices necessarily employed in it ar
so constant a source of danger, and accu
mulations of inflammable material in it s
difficult to avoid, that it should not be im
periled by the incorporation of wood i
its construction. The Temple Court fir
teaches a further lesson in showing th
danger that exists in very large window
ranged closely together, and with scarcel
more than the space between floor an
ceiling between different floors. There
little doubt, apparently, that the fire w
communicated from one floor to anoth
in this manner, the wooden-window fram
forming an effective means of transfe
ance. As it is further supposed that the fi
may have been in progress several hou
before being discovered, it is obvious th
by a rigid and careful inspection a ve
large amount of the damage done mig
have been prevented.

M. CORROYER'S book on Gothic arcl
tecture* may be safely recommended
all students of architecture. It is ve
French, as may be expected from a
French writer writing on Gothic arcl
tecture, and it would have been bett
perhaps, if the author had confined hi
self wholly to French art instead of usi
a few illustrations of foreign Gothic, wh
only help to make his general treatm
insignificant instead of adding to it. I
burdened likewise with a most impossi
theory on the origin of Gothic archite
ure, which M. Corroyer thinks is deri
from the cupola, typified in the cupolas
the cathedral of St. Front at Périgue
Hardly anything could be more impr
able, and it is unfortunate that the edi
did not enter a protest against it. A
summary of French Gothic architect
the book is very good. The examples
lustrated are numerous, and include
only general views and parts of buildi
but plans and sections, the later be
in many cases, new to readers wh
knowledge of Gothic architecture
been derived from English text-bo
The illustrations are well printed.

**Gothic Architecture.* By Edouard Corroyer
ited by Walter Armstrong. New York: Macmil

INDUSTRIAL CHEMISTRY.

Conducted by Dr. R. A. Witthaus.

HE recent experiments of M. Henri Moissan with high temperatures e most interesting and his results wellgh incredible. M. Moissan, however, eds no introduction, his work with the ement Fluorin being well known and a fficient guarantee of his exactness. It s been determined quite recently that, ving to imperfections in the pyrometers rmerly used, the temperatures above oo° C. have been grossly exaggerated. he highest temperature attainable by al-gas and an oxygen blast is about oo° C., while the highest temperature tilized in industrial work is only about 500° C. At the former temperature a uicklime crucible only can be used. ence it will be seen that the temperatures btained by M. Moissan are most remarkble. For these higher temperatures a urnace is constructed of two bricks of uicklime, carefully cut out and placed ne above the other, the lower brick havng two longitudinal grooves for the elecrodes and a small cavity in the middle to erve as a crucible. The arrangement is hus similar to that used in melting platinum. In the first experiments a small Edison dynamo driven by a gas-engine was used. A current of 30 amperes and 55 volts gave a temperature not much exceeding 2250° C. Later a current of 450 amperes at 70 volts was used, representing about 50 horse-power, and with this 3000° C. was attained.

At 2500° C. the oxids of calcium, strontium, and magnesium crystallized rapidly, and at 3000° C. the quicklime of which the furnace was composed ran like water. At this same temperature the lime was reduced by carbon, and the metal calcium was "liberated in abundance." A carbid of calcium was also obtained fusible at a red heat. Fine crystals of the borids and silicids were readily formed. Magnesia was melted as easily as the lime, and alumina was melted and crystallized at 2250° C. By the addition of a small amount of the oxid of chromium, artificial rubies were obtained. By continuing the treatment of alumina this was completely volatilized, thus providing a parallel case to the volatilization of silica, effected by Seger. Titanic acid was crystallized, fused, and volatilized according to the temperature, and zinc oxid was volatilized freely and deposited in long, transparent needles. M. Moissan, it is said, has also produced a number of microscopic diamonds by the crystallization of carbon after the following method: Pure carbon obtained by burning sugar was dissolved in an ingot of iron and this then heated to 3000° C. By the application of cold water a sudden crystallization was effected, and true diamonds of microscopic size were obtained. As M. Moissan is continuing his researches, further results will be looked for with interest.

TURNING from one extreme of temperature to the other, we have the investigations of Pictet in chemical action at temperatures ranging from -50° C. to -155° C. Under the influence of this extreme cold chemical action apparently ceases. For instance, 89 per cent. sulfuric acid, which freezes at -56° C., if cooled to -125° C., may be powdered and mixed with caustic soda of the same temperature without chemical effect. When this mixture is subjected to the spark from a Ruhmkorff coil, reaction slowly sets in and at -80° C. pervades the mass. With ammonia, sulfuric acid reacted at -80° C. to a limited degree, but at -60° the reaction was complete and there was a sudden rise in temperature. With sodium chlorid the acid gave no reaction at -50°

C., at 25° C. there was limited reaction, and above this the reaction was complete. The following are the author's conclusions:

1. At temperatures between -155° C. and -125° C. no chemical action is perceptible, whatever the nature of the substances employed.

2. Delicate tests, such as those with acids upon litmus paper, can be successfully applied at lower temperatures than may consist with very energetic reactions of other kinds, *e. g.*, that between sodium and sulfuric acid.

3. Every chemical action, according to the temperature at which it takes place, appears under one of two forms: (a) Slow action, which follows when the temperature is kept beneath a certain limit, varying with the substances employed, this kind of action being brought about either by an electric spark or spontaneously, depending upon the difference between the actual temperature and the above limit; (b) complete action, in which the heat generated by chemical union is communicated to the neighboring parts of the compound, until these are equally involved. In order to maintain slow action it is necessary in most cases that this heat be carried off by radiation; otherwise the temperature will very soon rise to that of complete action.

4. The best excitant of slow action is apparently the electric spark.

5. It is experimentally established that every chemical action commences with a period of negative energy, *i. e.*, a period in which external activity must be furnished to the component bodies, in order to allow of their combining.

AN interesting paper on the "vulcanizing process" for wood was read by Mr. H. C. Myers, before the National Electric Light Association at the St. Louis meeting in February. Pointing out that the annual consumption of wood in this country equals twice the amount of material supplied by the annual growth of our forests, Mr. Myers shows the necessity of wood preservation and wood strengthening. He then speaks of the composition of wood as it exists in nature: "Cellulose impregnated with resin, volatile oils, sugar, gum, tannin, protein bodies, and the usual mineral constituents of plants." In the distillation of wood the cellulose decomposes and a chemical change takes place between it and the natural constituents of the sap, resulting in a powerful antiseptic mixture containing acetic acid, methyl alcohol, acetone methyl acetate, tarry matter containing phenol, creosote, carbolic acid, and abou thirty other substances of lesser impor tance. Mr. Myers divides the processe now used for the preservation of wood int two classes: (1) those in which wood i impregnated with a preservative materi by immersion, and (2) those in which preservative agent is forced into the pore of the wood. Copper sulfate, zinc chlori mercuric chlorid, dead oil, etc., are amon the chemicals used. In the new "vulca izing" process the timber is heated to temperature at which the chemi changes, spoken of above, take place, b instead of distillation from the wood antiseptic products are retained un pressure. The process is described as f lows: The "wood is heated in clo cylinders from eight to twelve hours a temperature ranging from 300° to 5 Fahrenheit and under a pressure of fr 150 to 200 pounds to the square inch. circulation of superheated and dried c pressed air removes the surface moist and any water that does not enter into reaction and combine with the woody c stituents. Hence wood or timber in condition may be immediately trea These cylinders for the treatment are feet long, 6½ feet in diameter, and made of steel. As the treatment p trates to the heart of the timber, cons able time is required for cooling, whic of course, done in the cylinder and u pressure. Timber is introduced treated upon cars which run into cylinder on small tracks." The per age of dark antiseptic matter in the canized product varies with the diff woods, and in the samples examine Mr. Myers ran from a minimum of 5 cent. to a maximum of 59 per cent. process apparently makes decay impo ealing up the pores of the wood with iseptic matter and, moreover, by tests de at the School of Mines in New York , the average increase in strength after atment amounts to 18.9 per cent. Connative tests with like results were made Professor R. H. Thurston, and Profes- Alfred Trautwein, of Stevens' Institute, boken, and also by a committee of val experts. "The process of vulcaniz- g seasons all timber, thoroughly prevent- g any further warping, checking, or acking. Such timber is not influenced by mospheric agencies, bacteria, or spores, d requires no paint for protection, as it saturated with antiseptic preserving ma- rial of its own; the albuminous constitu- nts of the natural wood have been oagulated by the high heating and ren- ered insoluble." A further valuable ffect of the vulcanizing is in the rendering f soft and non-durable woods hard and ermanent. The loblolly pine of the South decays rapidly when untreated, but fter treatment is as durable as ordinary imber and ties used in railway construc- ion. "As vulcanizing changes the sap rom the liquid to the solid or semi-solid state, does not char or make the wood brittle, saturates and seals up the pores of timber with solid matter instead of liquid soluble matter which nature provides, considerable strength and durability are added by vulcanizing, the wood being rendered more cohesive, harder, and denser. The spike-holding quality is naturally much increased, and even after ten years' service railroad spikes seem to be as firmly imbedded as when just driven. It is also a curious fact that the electrical resistance of most woods is very greatly increased by vulcanizing."

PROFESSOR W. M. HARTLEY, F. R. S., has recently described a new process for the preparation of drying oils, consisting in first refining the oil, by removing therefrom the water and mucilage contained; second, boiling and bleaching the oil in one operation. For the removal of the water and mucilage, various processes are in use, as for instance by alum, by sulfuric acid, or by zinc chlorid, but all of these offer serious objections. With the zinc chlorid the expense is too great, while with strong sulfuric acid the oil, or some of its impurities, becomes charred, and a brown color is the result. Professor Hartley advises the use of pure neutral manganese sulfate, but for ordinary purposes dilute sulfuric, 30 per cent., answers well, withdrawing the water and precipitating the mucilage without charring. The oil thus produced is bright, clear, and slightly yellowish in color. Having been purified, the oil is ready for the next step, the bleaching and oxidizing treatment. Binks has long used the oxids of manganese in bleaching and boiling, but with indifferent success owing to the difficulty experienced in regulating the quantity of the manganese compounds to be added.

Professor Hartley prepares manganese linoleate, dissolves this in a hydrocarbon, and adds the solution to the oil. The coloring matters combining with the manganese compound are oxidized and destroyed, the manganese being deoxidized. Subsequent oxidation in the oil produces acrolein, formic, and acetic acids. The resulting oil is light in color and of excellent quality. In order that its superiority may be the more clear, the following defects in ordinary drying oils are pointed out: (1) Zinc white mixed with ordinary boiled oil darkens; (2) patent non-poisonous white lead is also darkened; (3) lead sulfate with ordinary boiled oil darkens; and (4) all delicate colors are darkened if mixed with ordinary boiled oil. The advantages of an oil made as described by Professor Hartley would be that zinc white, white lead, and all delicate colors when mixed therewith would retain their proper brilliancy and shade even after a considerable exposure.

FOR the purpose of comparing the river pollution of one time with that of another, Herr R. Baumeister proposes the use of a formula designed to represent approximately a coefficient of pollution. Chemical analysis fails in making these comparisons, owing to the wide differences in local conditions. Von Pettenkofer has laid down the rule that no harm can arise when the volume of sewer-water is not more than one-fifteenth that of the river into which it passes. Baumeister, however, shows the uncertainty of such a law, depending as it does on the variable factor of water supply per capita, and proposes more wisely to set down the population contributing to the sewers as the figure to be taken into account when calculating the pollution. Considering the suspended organic matter, and all matter, organic and inorganic, in solution, as pollution, he assumes 190 grams per capita per diem as representing the average amount of impurities discharged from water-carriage towns. As in many towns the dejections of only a certain proportion of the population reach the river, this proportion in the formula is represented by C and all other impurities by I, $I+C$ then representing the total amount of impurities conveyed to the river. According to von Pettenkofer, the velocity of the stream should at least be equal to the velocity of flow in the sewer, or not less than 0.6 meters per second. The coefficient of pollution then is represented by the formula: $\frac{Qv}{E(I+C)}$, in which Q equals the daily flow in cubic meters when the river is at its lowest level, or 86,400 q, q being the volume in cubic meters per second. V equals the mean velocity in meters per second. E equals the population, and C the proportion of the inhabitants who regularly contribute to the sewers as above stated. A table of coefficients for a few of the principal towns in Europe is given by Baumeister, but the formula is rather a suggestion, and exactness is not claimed, the author himself indicating some of its weak points.

THE following notes on smoke-prevention are abstracted from a report of the special committee of the St. Louis Engineering Club. The various apparatus and processes for smoke-prevention have in many instances proved to be unsuccessful mainly because of lack of care and attention, and also because of entire ignorance of the principles involved in combustion. By the application of heat the organic matter in the coal is decomposed, and "gaseous carbon" and hydrogen are given off, but the heat may not be sufficient to effect a chemical union between these gases and the oxygen of the air, in which case heat is absorbed. When the hydrocarbon vapors are decomposed, carbonic acid, CO_2, and water, H_2O, may result from the complete combustion of some part of them, while another portion has some of its carbon separated, leaving a light hydro-carbon gas, $C_2H_4=C+CH_4$. It is this separated carbon in an incandescent state which gives luminosity to the flame, and which forms the visible smoke during the burning of bituminous coal. For the combustion of this separated carbon a strong oxidizing influence is necessary and also a high temperature. If the high temperature be wanting, the carbon is carried along by the draught and passes off as smoke. The most important of the many types of smoke preventers are included under the following heads (1) steam-jets; (2) fire-brick arches, or checker work; (3) hollow walls for preheating the air; (4) cooking arches or chambers; (5) double combustion; (6) downward-draught furnaces; and (7) automatic stokers.

The steam-jet is used to force air into the fire-place either directly or after being heated, in quantity sufficient for the complete combustion of the gases. This requires care and regulation by an experienced hand. If the nozzles are not well-adjusted, a blow-pipe action is obtained upon the boiler or upon the grate-bars, and one or the other is thereby rapidly burned.

The fire-brick arches and checker work subdivide the current of gases, and maintain a uniform and higher temperature throughout. They are useful in this way, but the cost of maintenance is somewhat high. The systems based upon hollow walls and those upon the use of coking chambers were considered by the committee as objectionable. In the downward draught furnaces the fire-place back is closed, and the smoke and gases can escape only by passing downward through the fire-bed itself. Owing to the high heat thus developed on the bed, water-tubes are used in place of the ordinary bars. This em is regarded favorably, as likely to perfected and to be made of great ie. Automatic stokers supplying a ular and uniform feeding to the fire-ce by mechanical means were regarded oo limited in their applicability.

t is curious that where the combustion resumably the most complete,—that is, hout the production of smoke,—there is ss in the heating power of the fuel, an rease in coal consumption, and a loss in nomy.

N the February *Dixie* (Atlanta, Ga.) Dr. bert Grimshaw gives a short account of Hercules ironworks plant for the man-ture of ice at the World's Fair. This nt will be most interesting and will at-ct many visitors, for, though artificial is as common an article in our house-lds as is the natural product, still there e many persons—and not all of them dies—who have not the faintest idea of w it is made. The plant at the World's air will supply the demands of 175,000 ily visitors, and hence the 150x300 feet ace allotted to it will not be any more an is necessary. The building itself ill cover a space of 130x255 feet, will be ve stories high, and decidedly unique nd artistic in its simple decoration. The ngine-room, the first from the main en-rance, will contain three 120-ton "Her-ules" machines of the latest pattern. On ither side will be located the dynamos for oth arc and incandescent systems, air-umps, and motive machinery for the pas-enger and freight elevators. The engine-oom itself is 80 feet square, light and iry, occupying two of the five stories. At ne end is a raised platform for visitors. The boiler equipment will be of 800 horsepower and representing the two types of tubular and water tube boilers, which will be carefully compared. "Above the boiler-room is a fire-proof story in which will be located the ammonia condensers and water purifying apparatus. To the left of the boiler house and engine-room, and entered from the latter, will be located the ice storage house and the ice tanks for the manufacture of ice by both the plate and can systems. This department will be 100x130 feet in size, two stories high. To the ice manufacturer it will have the highest interest, since under one roof and side by side will be seen in operation the manufacture of ice under all conditions and by all the processes which have by experience been declared or deemed successful: (1) By the plate system, from filtered water; (2) by the can system from condensed steam thoroughly filtered and purified; and (3) by the can system from de-aerated water, thus giving all processes full representation. The tanks have nominal capacity for eighty tons of ice daily, but will be capable of producing ninety to ninety-five tons when required. By the plate system ten tons daily will be produced." Pneumatic hoists and electric cranes will be used in handling the ice. Storage capacity for 3000 tons of ice is provided, and also a cold storage for meats, vegetables, fruits, etc.

SPEAKING of powdered coal, Mr. R. H. Humphreys has recently made some experiments upon its use in gas-works which show that the old objections to its use are well founded. The experiments were carried on in a bed of three 15-inch round retorts working under regular conditions and using the same class of coal, screened and ground. With the ground coal a superior coke is produced and also an increase in the yield of the same, but the gas was deficient, as will be seen from the following: The consumption of fuel and of labor being the same, the screened coal could be worked off in six hours, or at the rate of four charges per day, yielding 15,600 cubic feet of gas; whereas the ground coal could only be worked at the rate of three charges per day, yielding 9010 cubic feet of gas. There was no improvement in quality with the smaller yield. The fine coal produced clouds of dust in charging and caused much discomfort to the workmen, no flame issued, and the temperature was lowered.

MINING AND METALLURGY.

Conducted by Albert Williams, Jr.

INCREASED use of various wet processes of treating ores has directed attention to the question of the best material for and construction of the tanks required. In handling small quantities wooden or light iron tanks answer the purpose; but when treating large quantities—the only way in which some processes can be advantageously applied—it is not so advisable to increase the plant by using greater numbers of the tanks as to increase the individual capacity of each tank. Economical handling calls for the least possible number of separate operations, and the work of charging or emptying is not so very different, whether the vat is a large or a small one. Formerly a maximum limit was supposed to be about 100 tons, but 360-ton wooden tanks have lately been built in the Transvaal, and there is no reason to believe that it would be impossible to construct iron or steel tanks of large size. A great difficulty with wooden tanks has been to prevent shrinkage and leakage. Various preparations of tar, asphaltum, etc., have been tried, metallic paints being inadmissible on account of chemical action. Paraffine also has been employed to prevent absorption and leakage.

In the use of some solutions the organic matter (the wood of the tanks) is found to have a reducing effect upon the solution, lowering its strength. For any process requiring especial minuteness in manipulation and which would admit of care at the expense of time, iron tanks of moderate size coopered with strong iron or steel bands, tautened with turnbuckles, are preferable; but it is doubtful whether any process can be worked to the best advantage on the small scale. For a permanent plant of large capacity the best construction is probably brick and cement, or cement built into excavations in natural rock. On this system the only limit to the size is that determined by convenience and the requirements of the process.

A LARGE proportion of the expense in any wet process is due to the labor of emptying the tanks of the spent material. Shoveling it out by hand is a slow and tiresome matter, and the various mechanical de vices (cranes, scoops, etc.) that have bee tried are not much better. The write once devised a form of settling tanks fo wet-crushing silver mills which was sel discharging, at the bottom.* Since the settling tanks discharging at the botto have been built in a few amalgamatin mills, as at the DeLamar, Idaho. Ev dently all leaching- and settling-tank ought to be self-discharging or as near so as possible,—that is, through the bo tom, or in the case of very small recept cles possibly by rotation and dumpin Cement-tanks can be discharged throu openings in the floors communicating wi tunnels, an arrangement already adopte

On the same principle the filling of t tanks should be as nearly automatic possible,—that is, by inclined chutes, ho pers, or dumping-cars run on tracks o the tanks. The economical working any lixiviation process, whether hyp cyanide, or whatever it may be, and of wet processes in general, will depend v largely on the arrangement of the appa tus and appliances for continuous do grade movement of all solid mate avoiding all needless handling and con ing the lifting work to the pumping b of water and solution. The problem is same that has been so successfully sol in the case of the great gold stamp mil California, South Dakota, and Ala whose remarkable records have been missible only by suppressing all unne sary labor. If a 120-stamp mill can be ix men per shift, why not a leaching t of equivalent capacity?

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* Transactions American Institute of Mining gineers, 1883.

HE California State mining bureau had arrow escape from being abolished by legislative session lately closed; but as been remodeled by a new act which plants all former organic laws, and r passing through the critical stage in history it begins a new tenure of life, h a new chief and a brand-new appro- ation of $50,000. It is to be hoped that der the present regime it may be of me real utility to the miners. Thus far immense amount of money has been pended upon it, besides which it has en liberally aided by private donations its collections and by volunteer assist- ice, but without commensurate results, less the voluminous and rambling re- orts published be considered as such. alifornia earnestly desires an efficient ining bureau, and has tried hard enough get one.

In Colorado a bill to establish a similar tate mining bureau has been killed in he legislature. Perhaps it is just as well. The purpose of such organizations is wholly commendable, and one can imagine a mining bureau which would be a source of authentic information, a great help in developing the resources of the State, and a trustworthy guide to investors. Unfortunately, if past experience with corresponding organizations is any test, the sanguine hopes of the promoters would be unlikely to be realized had the bureau been created. Before an efficient bureau could be established certain prerequisites are in point. It would be necessary to make sure of a decided change in the tone of local politics and to have available a personnel that would command the respect of public opinion, have some interest in its work other than that of drawing salaries, and be technically competent. It is generally found that in such cases the men in charge are either beguiled by "high science" on the one hand or are contented with practical politics on the other. Colorado has already a labor commission and a World's Fair commission, and has learned that the chances of useful results in this line of work—results worth the expenditure—are not enticing.

AMONG the great silver mines of the day, the world over, that of the Broken Hill Proprietary Co., New South Wales, unquestionably takes the lead. Its record is still below that of the bonanza mines of the Comstock, but it has already paid dividends amounting to $18,363,120, cash bonuses of $2,883,040, and stock dividends of a nominal value of about $8,500,000. For the first time in its history the last semi-annual report shows a falling off from that of the preceding half year, this being explained by the long stoppage during the fall of 1892 on account of a labor strike; but it yielded 2,310,208 ounces of silver and 9650 tons of lead, from 73,973 tons of ore, during the six months. The average cost of mining was $8.024 per ton; of smelting, $8.18 per ton; and total average expenses, $18.73. The gross yield being $27.37, the net profits were $8.64 per ton. Apart from its productiveness, the mine is remarkable for the problems presented in its technical management, much difficulty having been experienced in avoiding creeps and cavings with ground so extensively stoped, while the proper treatment of its complex ores has been a puzzling and disputed question. Its reduction works include plant for concentrating, smelting, leaching, amalgamating, and refining, and there has been no lack of experimentation in various directions. The most serious metallurgical mistake which seems to have been made was one that has often occurred in other districts where true smelting ores have been the main reliance, and that is the selection of the richest and most easily reducible ores for smelting at first, thus leaving the more refractory to make trouble later, instead of attacking the whole metallurgical question in its entirety at the outset, and regarding the true smelting ores as the basis and economizing their fluxing qualities to offset the objectionable elements of the dry and refractory ores. An agent of the mine visited the more important reduction works of the United States last year in order to study the best American practice in treating similar ores. The smelting cost at Broken Hill ($8.18) is not very high, however, and will probably be reduced somewhat by the addition to and improvements in the company's plant.

THE greatest silver-producing mine in South America at present is the Huanchaca, situated in a group of hills on the central table-land of Bolivia, at an altitude of 13,400 feet. A railroad 395 miles long connects it with Autofagasta, a Chilian port. Since 1876 the gross production has been about $46,000,000, of which about $15,000,000 has been paid as dividends. The expenses have been very high,—$28 per ton for mining, hauling, and sorting, and $24 for milling. A large amount of low-grade ore (that is, low-grade for the locality) has accumulated; and now that the railroad has been completed it is the intention to discard the expensive mill near the mine and treat the low and medium ores at large works on the coast, shipping the highest-grade ore.

CHROME iron-ore mining in California, according to the *Mining and Scientific Press*, is in an unsatisfactory condition owing to various causes,—the great distance from the centers where the ore is utilized and the cost of freight to these markets (Baltimore and Philadelphia mainly), the desultory manner in which mining is carried on, and the need of good wagon roads and near-by railroads. There are many known deposits, but they are mostly in pockets; and of the larger ones at a distance from transportation facilities the richer ores have been taken out and shipped, leaving the poorer ores until the conditions will admit of their being profitably mined and shipped. There is no apparent chance of establishing a chrome steel industry in California, but it would appear that there is an opening for local manufacture of chemical products from chrome ores, which ought to pay better than shipping the crude material.

LOWER expense records than that of the Alaska-Treadwell gold mine, Alaska, have been made; but considering the conditions its showing for the last year is a notable one. There were 120,000 tons of ore mined and treated, at a total average cost of $1.82 per ton, divided as follows: Mining, 65 cents; milling and concentration, 33 cents; chlorination, 15 cents on the total tonnage, $8.42 per ton of concentrates; general mine expenses, office expenses, bullion freight, insurance, etc., 15 cents per ton. People who have schemes for improvements in gold metallurgy would do well to consider these figures.

ABOUT 15 per cent. of the gold output of the Rand mines, South Africa, during the last half of 1892 was obtained by the cyanide process. Twenty-four of the companies operating there are either treating or are preparing to treat their tailings by this method, and it is estimated that some 150,000 tons of tailings will have to be treated monthly by this process. Mr. W. G. Shaw, in the Johannesburg *Star*, says that the day may be looked forward to when 3-dwt. tailings will thus be profitably handled. He gives some very favorable figures for the working results, and says: "After a careful course of inquiries, I consider the average cost of treatment by cyanide to be $1.65 per ton, with an extraction of 67 per cent. of the gold." This is by no means as high as the promoters of the cyanide process claim, but it is very much better than its detractors allege.

RECENT discussion of the genesis of metalliferous-ore veins has elicited interesting expressions of opinion from mining engineers, but it is to be remarked that such men prefer to appeal to observed facts rather than to *à priori* theory. In the debate between the adherents of the lateral-secretion theory of Sandberger on the one side, and of the deep-seated source theory of the older geologists on the other, it is well to remember that there is no necessary antagonism between the two ideas, unless either or both are pushed to a degree of exactness which is unwarrantable by actual occurrences viewed as a whole. The more advanced supporters of the lateral-secretion theory apply it as a very flexible hypotheonly claiming that the ore is derived mineral preëxisting in the country is somewhere in the neighborhood of the osit, from above, from the side, or even n somewhat below, but in the course of colating waters from the surface, which y reascend under hydrostatic head as l as descend or flow laterally. There o reason why we should be limited to one particular explanation of the mode vein filling. Some veins may be formed one way, some in another. Nature is niggardly in expedients.

ALUMINUM has some new applications. ne is in the manufacture of the sound- ses or bodies of violins and other stringed struments, for which its resonant quality s it. Another is as durable "slate ncils," the metal having been found to ark well on slate of proper grain. It has een successfully tested as a material for orseshoes in the Russian cavalry service, nd may come into common use for the hoes of racehorses. There has been some alk of adopting it in the German army for he metallic parts of military accoutrements, in order to reduce the weight carried by the soldiers, and even for cartridge hells in place of brass or copper.

IN a paper on underground haulage by electric locomotives in coal mines, by M. Clément-Baily, a Hainault engineer, the drawbacks of chain haulage (which would apply in part to wire-rope haulage) are summed up as follows: Higher first cost; encumbrance of the main roadways, so that an accident may interrupt the output; and the necessity generally of a double line of way, forming an obstacle to the passage of the men. These objections, in conjunction with the rapid progress of electric haulage during the last few years, are influencing the preference of foreign engineers for the electric system wherever applicable, as is shown not only by the actual adoption of that system to a large extent in French, Belgian, and German mines, but by the tone of the papers read at the meetings of European engineering societies and the discussions in the technical press. In this direction it appears that American practice is hardly abreast with the most advanced practice on the continent of Europe. This may be due to the well-grounded apprehension that the use of any electric motor that is liable to sparking in a gaseous colliery would introduce a new element of danger. M. Baily, arguing in favor of electric haulage, makes these points in contrast to those just cited: That the installation is very simple; that the gangway may be kept single; and that in case of a breakdown the electric locomotive may be at once superseded by horses or mules. He also adds that the electric locomotive, besides being more economical than horse traction, conveys the men to the working places rapidly and extends the radius at which coal may be mined from the shaft.

SOMETIMES it happens that a reported or proposed metallurgical process seems "in the nature of things" to be a chemical impossibility. Whenever we are confronted with a case of this kind, it is well to recall some past surprises and be cautious about forming negative judgments from preconceived limitations. Many such warnings have been given, but forgotten. A good instance in point was the upsetting of dogmatic opinion brought about a few years ago by Professor Dudley's neat little trick in fusing and molding iridium. This metal was considered hopelessly refractory, —a feature much deplored in view of its useful qualities for certain purposes. To make an easily fusible phosphid, manipulate it into shape, and then expel the phosphorus seems simple enough now that we know how it is done—like the mythical egg of Columbus, to use a trite simile. There are plenty of problems that are now puzzling metallurgists which doubtless admit of unexpectedly easy solution, and which are destined to be solved some time or another, very likely by accidental discovery. Then it will be wondered why somebody in 1893 hadn't the sense to see how.

ONE reason for the recent labor troubles in the precious-metal mines of the West, it must be confessed, has been a certain lowering in the general average tone of the men, a point in singular contrast to the immense improvement in the technical methods of mining during the last few years. This is deplorable, and the statement may arouse opposition, but there is no use in concealing the undeniable truth. It used to be a matter of common observation that the farther one went from the railroads and beaten tracks, the more intelligent the men one would meet. They were the pioneers, the prospectors, and naturally more enterprising than the ordinary mine laborers. Such men were not strikers, and when they joined the miners' union they retained their common sense. In large part they were Americans, not satisfied with being mere wage-workers for life, but working at times for wages in order to become free to prosecute prospecting or mining on their own account, and hence more in sympathy with temporary employers. Now the railroad goes almost everywhere, and a cheaper, less enterprising class are coming in. So far there is no great influx of Huns, Poles, and Italians, but there is a decided approach to the tone of the eastern coal mines, and it is only a question of time when the average for the whole country will be equalized and the "labor problem" become a more serious one. It may be wondered whether the labor problem in Australia, so vividly depicted by Mr. Edmund Mitchell in the April number of this magazine, was not due in part to a deterioration of tone caused by the later immigration.

BLOCK TIN is again on the free list, the bill to prevent the taking effect of the McKinley tariff act in the case of tin having been passed by Congress at the close of the last session. Thus far neither the Broad Arrow, the Rockbridge or King's Mountain, the Temescal or the numerous properties of the Harney Peak Co. have come up to the flattering predictions and anticipations. One of the strangest facts in the mineral history of the United States has been the failure to achieve better results in this direction in view of the great number of known occurrences of tin ore, their wide geographical distribution, and the persistent and costly attempts made to develop profitable tin mines. Of course there are still chances for the establishment of a real tin-mining industry, and it would be foolish to venture on negative prophecies. The country needs tin and will have to continue importing it for the present, if a tin-plate industry is to be buil up, unless something unexpected happen to the tin mines or new deposits are found At the same time it is well to remembe that the making of tin-plate is rather branch of the iron and steel trade tha anything else. The proportionate amoun and value of the pure tin to the whole cos is not very large, manufacturers havin learned to get along with about 3 per cen and for cheaper grades only about 2 pe cent. of tin in the total weight, the mai expense being for the rolling and man pulation of the sheet iron and sheet ste used for the body of the plates.

FAVORABLE reports come from Idaho opal field. The town of Opaline has stag roads running to it. Mining is being sy tematically, and it is said profitably, pu sued in spite of the scarcity of water, remedy which it is proposed to sink art sian wells.

FIVE folios of the geological atlas of t United States, and proof copies, have be kindly furnished this department by C onel H. C. Rizer, chief clerk of the Unit States Geological Survey, who writes th as the folios have passed the experimen stage it is hoped that their publication large editions will be begun in a sh time.

THE anthracite coal monument for Columbian Exposition has been prepa by the Lehigh Valley Coal Co. It is ab fifty feet high, ten feet square at the ba and three or four feet square at the *Black Diamond* reports that experts w have examined the plans and work that the exhibit will be one of the fin ever made in the interest of the anthra trade.

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WHAT WILL THE DEMOCRATS DO?

A FORECAST OF TARIFF LEGISLATION.

By John DeWitt Warner,

Member of Congress from the Thirteenth New York District.

FOR the first time since March 4, 1861, the three branches of the law-making power in the United States are now Democratic. After a generation of no or divided responsibility, the Democratic party can legislate as it pleases and execute in favorable spirit the laws it enacts. Moreover it is now in charge of the government of the United States at its own request, upon its representation that there is needed, not merely a radical reform in administration, but a radical change of public policy in most important respects, requiring sweeping legislation, which shall revolutionize our system of federal taxation by abolishing its most important present characteristics, and adopt a currency system of which honesty shall be the base and freedom from federal bedevilment the characteristic. Such is the promise it may be expected promptly to perform.

These subjects, it appears to me, properly find place in the scope of "a review of industrial progress," such as THE ENGINEERING MAGAZINE. Its reading constituency embraces the heads of many important manufacturing enterprises,—men who in the varied relations of life are potent factors in forming public sentiment and in making the real progress of the country. A large number of these men are, or have been, protectionists, and they naturally feel an interest, if not an anxiety, with regard to the trend of forthcoming legislation. Those among them who are advocates of tariff reform, at the same time, are looking with interest for the fulfillment

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of the pledges under which the new administration at Washington has been placed in power.

I.

As to the tariff, the principle by which legislation will be guided is the one inserted in its platform by an overwhelming vote of the body of the Chicago convention, viz. : that "*the Federal Government has no constitutional power to impose and collect tariff duties, except for the purpose of revenue only*" ; and the special details of tariff legislation promised are "*free raw materials, and cheaper manufactured goods that enter into general consumption.*"

"Protection" as a principle can therefore find no place in the general tariff system which will be substituted for that devised by McKinley and repudiated by the American people. In the adjustment of a revenue tariff the result of many an item will, indeed, be such as can and will be taken advantage of by the domestic manufacturer to exact an extra bonus from his fellow-citizens. He will, however, no longer be listened to when he asks that the tariff be adjusted to that end. His protection, if he receives any, will be accidental rather than even incidental,—such as, after the tariff has been adjusted for revenue, he may find, rather than any which by adjustment he may seek to obtain. Such favoritism as is still thus left will be immaterial when compared with that deliberately provided by our present laws, and simply one of the evils which can be redressed only by abolishing tariffs in favor of other means to raise revenue. These means have their special objections as well ; and while the Democratic party is not committed to the use of the tariff as a resort for revenue, yet, on the other hand, it is not committed to its abolishment.

That raw materials will be relieved entirely from tariff taxation, and that partially manufactured materials for further manufacture will be subjected to merely nominal or low duties, is certain,—the former by the direct promise of the platform, and the latter as involved in its principles.

As to manufactured goods of general use, there will be imposed on them no duty other than a very moderate one. This follows especially from two considerations :

I. In the first place, these are the articles, generally speaking, as to which facilities of production are enjoyed by one or more foreign countries in common with our own, and the fact of considerable imports under any circumstances rises, therefore, rather from some comparatively immaterial and often temporary advantage utilized by the foreigner than from causes which make it wholly or permanently impracticable for the home manufacturer effectively to rival him; and with the removal of the duty on raw materials and the reduction of that on partially manufactured articles, our home manufacturers will be still more nearly and promptly on even terms with their foreign rivals. In most cases, therefore, a high rate would be so largely prohibitory as to reduce the probable revenue below that to be secured by a much lower rate, which would permit comparatively liberal importation.

II. Again, there is an even better reason why high duties on manufactured goods which enter into general use can form no part of the new tariff; the framing of which, as must constantly be kept in mind, will be guided by the fundamental principle that the federal government has no constitutional power to impose tariff duties except for purposes of revenue only.

It is easy to quibble over this; but there is no question as to what the average citizen has a right to understand by it. It means that taxation must be justified by its revenue results, and by them alone. If these results are such as to justify any item, if the return to the government is such as to justify the extent of the exaction thereby made upon citizens, then the mere fact that incidentally, or rather accidentally, it gives an advantage to some home producer does not make the item an illegitimate one. If, on the other hand, however, the exactions upon citizens are so great as to be out of proportion to the comparatively small return of revenue to government, then not merely is the item on its face an unjustifiable one, but the fact that home producers get the lion's share of what is thus extorted ftom their fellows characterizes it as oppressive, and points it out as the very abuse the Democratic party is pledged to remedy.

In this connection it may also be expected that the principal tariff trusts will be struck a fatal blow by making their products free of duty. This is not merely in accord with the general condemnation of trusts, which was included as a plank in the Chicago platform, but is involved in the fundamental tariff principle already quoted. For to the precise extent that a successful trust secures monopoly of a tariff-protected article, its practice uniformly is so to adjust its prices to the importing rate as, while taking advantage of the protection thus afforded, fully to supply the home market and thus to leave the government without revenue from the tariff on the article in question. The tariff item thus treated becomes demonstrably not one essentially of revenue, and therefore must be abolished as an unconstitutional exaction. For example, the one-half cent per pound on the total amount of refined sugar used in this country, which is added by the McKinley tariff to the profits of the sugar trust, but which produces no revenue worth mentioning, will find no place in a Democratic tariff bill; while the revenue from the tariff on window-glass, being regulated by the trust which controls that product and which naturally keeps for itself the greater part of what the people are made to pay, is another example of the tariffs that "must go."

The new tariff law will also be much more simple than is the present one. So long as the question was one of the distribution of government largess to those claiming the right to tariff "protection," the theoretical tariff must be as complex as is the development of manufacturing industries with their infinite ramifications and interdependencies; and a tariff scheme on this theory, however defective, was a labored series of the permutations and combinations of personal and political considerations affecting either separate classes of manufacture, on the one hand, or members of Congress, on the other. But when revenue is the exclusive end to be subserved, and it is remembered that no system of taxation devised by man can be made to bear with perfect equality on all affected by it, and that tariff taxes are by nature uncertain and unequal in their final incidents, there will remain no reason for even attempting to adjust their burdens, except on broad lines and so as to keep resulting inequalities within reasonable limits. This simplification will probably include a great extension of ad valorem as compared with specific rates of duty, this (1) as a comprehensive alternative to elaborate grading in specific rates, to secure substantial equity of taxation, and (2) to obviate fraud. The former is so well understood as to need no explanation here. As to the latter, a word may be justified:

It is easy to suggest that, if an article *X* is subject to a specific duty *A*, there is no inducement for undervaluation by the importer. The actual examples, however, are much like these: Upon the article *X*, "provided it contain not more than 15 per cent. of alcohol," a duty of fifty cents is levied, and, provided it contain more than 15 per cent. of alcohol, $1 is levied; or on goods valued below 50 cents per yard 40 cents per yard is levied, and on similar goods valued between 50 cents and $1 per yard 80 cents per yard is levied, and upon all goods valued over $1 per yard $1.50 per yard is levied; or upon specified goods of less than so many threads to the inch a duty is fixed at 20 cents per yard and increased to 40, 60, and 80 cents according as the number of threads per inch passes certain arbitrary limits; or it is provided that specified goods "not suitable" for certain uses shall pay a certain duty per yard or pound, but, if suitable for these uses, they shall pay double that rate; or that certain articles "not commercially known" by a given term shall pay a certain duty, while if commercially so known they shall pay a different duty. These illustrations might be extended indefinitely, and, when combined with the "minimum" rate provisions, or "compounded" of ad valorem and specific rates, are hard to comprehend by other than tariff experts.

Indeed, the possibilities of evasion of duties are indefinitely multiplied when the fraudulent valuation, count, or estimate is effected by adding an extra thread, mixing a petty per cent. more of an ingredient, or slight prevarication as to comparative fitness for certain uses. Taking the treasury cases, one sees at once that it is not by questions rising on ad valorem duties that custom-house inspectors are mainly occupied and our court dockets filled with adjudication of revenue frauds, but that it is in the cases which rise under specific duties that this trouble occurs; and the extension of the ad valorem system will therefore subserve the ends of convenience as well as those of equity.

It is not possible here to discuss even briefly many of the more important of the single items involved. It may, however, be proper to note a few, presumably of special interest to the constituency of this Magazine.

It may be expected that iron ore will be put on the free list. It is a typical so-called "raw material," hence certain to be so treated by Democrats who believe in promptly carrying out the Chicago platform. Moreover, with the development of the Vermillion and other iron ranges, including the Giant Messaba, the competition for the supply of the western and central portion of our country is finally settled about Lake Superior as compared with the seaboard slope east of the Alleghanies. In other words, the section that but shortly since procured "protection" in order to enable it to control the extending market afforded by our country's development now sees this market exploited by those who, except for the more inviting new worlds yet to be conquered in the West, would drive the East from its home fortresses. As a result, the eastern seaboard is abandoning the attempt to control the western market for bulky iron products, and is anxiously devising economies and facilities to hold its own market in this regard, while still extending its sales of the more specialized lines of manufacture; and the capital and local interests of New England, New York, and New Jersey, which have for years demanded relief by free raw materials, are now being reïnforced from Pennsylvania, Maryland, and West Virginia.

With coal, somewhat similar conditions are adding daily to the interests to which free coal is a longed-for advantage; and in this case the relations of our western coal-fields with central Canada are such as to offer the further inducement of a far larger foreign market for Mississippi-valley coal by reciprocity in this respect than would thus be given in the United States to the coal of the Canada seaboard; while our Pacific States are at the same time finding it more and more desirable to secure cheaply the coal of British Columbia.

Though logically not so urgent, yet the extent to which the interest that would still shut them out is becoming plainly confined to a few, who wish to monopolize the advantages of the riches which, in their opinion, the Almighty has too generally distributed, to the direct detriment of a far greater number both of capitalists and laborers among their own countrymen, bids fair to secure the admission of silver lead ores either free or at a nominal duty.

These so-called "raw materials" being put on the free list, or admitted at nominal duties, a substantial reduction in duties on manufactured goods would follow. For it would be an indefensible increase of "protection" to leave untouched the present rates on manufacture while taking the duty from raw materials.

Similar considerations apply to the wool schedule. Not merely has the number of those who believe themselves interested in cheap woolens, as distinguished from dear wool, steadily so increased that the latter are a disappearing minority, but even they are beginning to appreciate that their only hope for a good wool market lies in promoting wool manufacture by free foreign wools rather than attempting to add to its profits by high duties.

Free wool will involve a reduction of the duty on manufactured woolens. Protectionists have had their day in chuckling over their witty suggestions of absurdity in the idea that tariff reformers are striving at once for a better market for wool and cheaper woolen goods; and the mass of our citizens are beginning to appreciate—what every business man understands—that at the center of every manufacture are its raw materials highest in price, and its products the cheapest and best.

To-day the United States is the largest consumer of woolen goods upon the face of the globe, and we are using a constantly larger proportion of all woolen goods made in the world. In addition, we are the only nation whose consumption of these goods can be regarded as considerable and whose wool product is so great a factor in the world's stock of wools. We are so situated also as under natural conditions to avail ourselves of the world's growth of wools to as great an extent and as easily as any other nation. The industry of wool manufacturing long ago reached the point where it involved just those factors of ingenuity and enterprise in which we, as a people, are most prominent. Under natural conditions, therefore, not in London, but in New York or Philadelphia, should be the great wool market of the world—where wools of every class and grade should be worth more than at any other place. It is here that should be centered the wool mannfacturing business of the world; and instead of importing so large a proportion of the woolens which our people use, we should be exporters to all quarters of the world.

I may be asked my grounds for believing that such a policy as I have outlined can be enacted into law. It is less radical, when compared either with the general drift of public expression or the official utterances of the party, than was the Mills Bill when it was presented. It will be pressed by the added pertinacity and force that have been developed by the demonstration of the elections of 1890 and 1892 that it is the popular will. Its opponents will have lost from the serried lines of monopoly, that were so nearly routed six years since, the time-servers who then thought they were on the winning side, the growing body of manufacturers who have lately tasted the ashes of the Sodom apples of protection, and the rapidly growing number of those who appreciate that even successful resistance now would only further deplete their own ranks and add to the overwhelming demand for a still more radical measure.

As to our export trade, the first effect of a reduction of tariff taxation will be largely to reduce the cost of those manufactured goods that are the necessities of life to a civilized people. As a result, the people will purchase more of them. Such is the object of tariff reform,—to help each to get more of everything he wants. This increased demand will be divided between home manufacturers and foreign ones. On the one hand, we will import more goods than we now do, and at the same time we will manufacture and market at home more than at present. The greater the freedom of commerce, the greater the advantage secured the energetic, the enterprising, and the far-sighted manufacturer, and the more promptly his incompetent and illiberal rival is sent to the rear This weeding out of weak concerns by the sharpened rivalry of the really strong ones will be one of the most beneficent results of the impending legislation.

This, however, is not the greatest advantage certain to come from freer commerce. Our imports will increase at the same time as will our consumption of home manufactures. This will stimulate exports, and our agricultural products will be given an increased market. Nor is this all. Raw materials made free, our manufacturers will in great measure find that even at the reduced price of their products their profits are as great as now; while to those among them who have the enterprise to exploit it will be thrown open a wider field for the export of their product. This country, with the greatest natural advantages vouchsafed to any nation, is inhabited by the most enterprising and industrious people in the world. With freer commerce the United States will more and more dominate the rest of the world in manufacturing.

A probable consequence of the tariff reforms about to be adopted is the exploiting of new sources of revenue. For it is as unlikely that without reimposing taxes upon sugar, coffee, and tea (which is politically out of the question), or imposing duties upon manufactures in general use at so high a rate as to make them essentially protective (which would be a breach of faith), we can meet the expenditures of the next few years, as it is undesirable that comparatively permanent taxation should be adjusted to the extraordinary but temporary demands of the treasury. Congress may therefore be called upon to choose between several expedients: the issue of deficiency bonds from year to year till they can be cancelled by surplus revenue later accruing, or the imposition of an income tax, which universal experience has shown to be the exaction most easily adjusted from year to year without risking the business interests, having each been suggested from many quarters. The well-grounded prejudice against the incidents of an income tax, albeit its comparative fairness is universally conceded, would seem to indicate that the former expedient would be deemed preferable, especially in view of its special advantages, too obvious to need discussion here.

II.

Less involved in long-standing party pledges, but in public interest from time to time frequently approaching the tariff, is the silver problem. This was recognized in the Chicago platform by three promises in such regard: (1) that the Sherman act of 1890 shall be repealed; (2) that, while the coinage of both silver and gold shall be "favored," yet the dollar units of both metals shall be kept on parity, *either* by coining them of "equal intrinsic and exchangeable value," *or* by "international agreement," *or* by "legislation"; and (3) that the prohibitory 10-per-cent. tax on State-bank issues shall be repealed.

Though as to incidental questions there may arise serious grounds of difference, yet in essentials the course to which the Democratic party is pledged is clear. Looking at these essentials only, it is, I believe, true that so overwhelming is the conviction of the party in accord with its promises, and so considerable is the extent to which the business interests and political common sense of the country are in accord with it, we may expect these essentials to be enacted into law. The Sherman act will be repealed; and, probably as a twin measure or by the same bill, federal inhibition against State-bank currency will be abandoned under conditions which will leave to the government the least administrative power necessary to secure soundness of such State-bank notes as are issued, leaving their amount to be regulated by the needs of local business, and their elasticity to meet the demands of commerce.

As to the remaining question, free coinage of both silver and gold will be "favored" as far as is possible within the alternatives described by the Chicago platform. Should it be possible by international agreement to assure a stable ratio between the two metals, the Democratic administration may be trusted to facilitate this, and a Democratic Congress to enact the necessary legislation. In event of the failure of international agreement, should federal legislation be devised equal to the situation, Congress will promply enact it; and in default of both these expedients, then, if any considerable body of our citizens claim the fulfilment of our platform pledge by legislation that shall require gold and silver to be coined from time to time at such a ratio that the coins issued at any time of either metal shall be of "equal intrinsic and exchangeable value" to those of the other of the same face value, it would be the duty of Congress to consider such legislation,—though so improbable is it as scarcely to justify its present consideration.

GREAT BRITAIN AT THE WORLD'S FAIR.

By James Dredge,

British Royal Commissioner.

IN my opinion the British section at the World's Columbian Exposition will do full credit to neither England nor Chicago. Facts may, and I hope will, show that this opinion is incorrect; but, even should the section develop into a brilliant success, it cannot fulfill the highly-colored predictions concerning it with which the newspapers, and especially the Chicago newspapers, were flooded some time ago.

What I wish especially to emphasize is this: that neither by American nor by foreign visitors and customers must the display in the British section be regarded as representative of the industries of England, but rather as the best that could be done by an energetic royal commission to induce a certain number of British manufacturers to take part more or less completely in the great show at Jackson Park. As regards the number of exhibitors, Great Britain does not compare favorably with the part she played at the Centennial at Philadelphia in 1876, and, although she has a far larger allotment of space at Jackson Park, yet in Philadelphia she occupied one-seventh of the total covered area, while this year she will occupy less than one-fifteenth. It may be assumed from this that Great Britain has not held her own in the Columbian celebration. Approximately we have (apart from the fine arts) 580 exhibitors in all classes of industry,—a very poor total as regards numbers, though this deficiency might be compensated by the high class of exhibits—a point we will examine generally later on. The following table gives only approximately the area in square feet that has been allotted—always in the best locations—in the various buildings and the number of exhibitors:

DEPARTMENT.	Square feet.	No. of Exhibitors.
Agriculture	14,176	75
Horticulture	656	18
Fisheries	1,300	11
Mines and Mining	8,000	33
Machinery	40,000	56
Transportation	54,257	80
Manufactures	100,400	191

Liberal Arts	64,240	103
Electricity	8,289	11
Woman's Building	2,384	...
Forestry	1,700	2
Fine Arts	20,325	...
Total	315,727	580

[In the Fine Arts Building there are 1130 pictures shown, and in the Woman's Building there are quite a large number of entries in the catalogue.]

Very briefly I may endeavor to analyze the nature of the objects comprised in the foregoing list, but this summary must necessarily be regarded as imperfect.

In Agriculture (Department A) we have mustered some 73 exhibitors, including two in the Forestry building—the Bombay-Burmah Trading Corporation, and the Indian Government, both showing specimens of teak, padouk, and other woods. One of our most promising and attractive exhibits—that of the London and Provincial Dairy Company—has been lost to us and to the exhibition, the facilities offered to the company not having been considered commensurate with the outlay and trouble involved. Whiskey, mineral waters, meat essences, and malt liquors make up more than forty out of the seventy-three numbers in this section. Of considerable interest will be the display of the British Beekeepers' Association, and the model of the Burdett-Coutts Brookfield stud-farm. Exhibits of agricultural machinery are absolutely wanting, and little or nothing in the way of cereals can be expected from a country dependent upon foreign sources for the greater part of its bread-stuffs.

Horticulture (B) in the British section is doomed to failure, and, considering the large and ever-increasing trade with America in this choice industry, the absence of many well-known exhibitors is inexplicable. British horticulture is not fairly represented by jam and condiments, and the credit of this industry, in which we take so great pride in England, must depend upon the extent of the display made by Bull & Cannell, Carter, Kelway, Laing, and Waters.

In Department C—that of livestock, domestic and wild animals—we are promised two exhibits, both being incubators. I do not think it strange or unreasonable that British stock-raisers should have declined to incur the risk of transporting valuable beasts to Chicago and of keeping them there with the prospect of an enforced sale at a depreciated value at the end of the exposition.

The eleven exhibitors in Department D—that of Fisheries—may be dismissed in a very few words; two or three models of smacks and trawlers, rubber boots and waders, fish-hooks, eel-traps, and feathers and flies comprise our contribution to this industry, in the which we are infinitely behind the United States.

In Department E (Mines and Mining) we make a very unsatisfactory display. The section is filled as follows: A cabinet collection of economic minerals comprising a great number of specimens arranged with much care by Mr. Bennett H. Brough; a few specimens of fuel—cannel, smokeless and steam coal, coke, and compressed blocks; some plain and enameled slate; granite, fire-clay, fullers' earth, and china clay; Portland and other cements by five exhibitors; salt by three exhibitors; while the metallurgy of iron and steel and its products is represented by steel bars, castings, and forgings sent by Jessop & Sons, of Sheffield, and by a few articles from the Low Moor Co., of Bradford. Messrs. Johnson, Mathey & Co. contribute specimens of platinum and platinum goods.

In the Machinery Department (F), where we have a large space for our fifty-eight exhibitors, a few objects of very considerable interest will be seen. Messrs. Galloway & Co., of Manchester, and Messrs. Willans & Robinson, of Thames Ditton, both send fine specimens of engine work. The latter, indeed, have promised three engines, one of 300 horse-power, driving a Siemens two-pole dynamo direct at a speed of 350 revolutions per minute. Messrs. B. & L. Massey's display of power hammers may be good, and the textile group will be comparatively strong, comprising nine well-known makers, several of the front rank. It is in this group that Messrs. Platt Bros. & Co., of Oldham, make a fine show of cotton cleaning, carding, and combing machinery, which will not only attract interest, but should certainly lead to extensive business results for the exhibitors.

The Transportation Department (G) with its eighty exhibitors will probably be the most satisfactory part of the British section. English locomotives and rolling-stock, including the historical "Lord of the Isles," will attract much interest, but the models of marine engines and vessels form the leading feature. Nearly twenty of the leading British marine engineers and steamship companies are well represented. In this department at least we need not, I think, be ashamed of our participation, though from all appearances we shall be greatly inferior to Germany. It should be mentioned that one firm of steel-makers exhibit in this building,—Messrs. John Brown & Co., who show an armor-plate.

It would be beyond the scope of this brief summary to analyze the one hundred and ninety exhibits in the Manufactures Department (H). Part of such a summary would, as usual, be a long story of fancy soaps and essences, colors, varnishes, wall-paper, etc. Some sixteen manufacturers represent furniture and internal house decorations, and these, with the furniture and fittings of Victoria House,—the headquarters of the Commission,—should be good enough and important enough to leave a permanent mark on the corresponding branches of American art industries. In ceramics the names of the Coalport Co., Doulton & Co., Daniells, the Worcester Royal Porcelain Works, and one or two others, are an ample guarantee that in one point at least the British section will rank high, and with almost equal confidence it may be asserted that in precious metal work the Goldsmith and Silversmith Co. will uphold the credit of the British craft against all comers. Textile fabrics will be represented by almost twenty exhibitors; clothing by sixteen others; lace and artificial flowers by a few more; and so forth. But the glory of the department is centered in the ceramics and the display of gold and silver ware.

The less said about Department J—Electricity and Electrical Appliances—the better. Apart from Mr. Preece's most interesting collection of historical telegraphs and electrical instruments (if it arrives), there does not seem to be a single entry worthy of being displayed anywhere. Parsons's steam turbine and dynamo, the only serious and novel exhibit, has been withdrawn, leaving the section absolutely barren.

In the Liberal Arts Department (L), including education, literature, engraving, public works, music, and the drama, we have about 100 exhibitors, and in addition quite a fine collection of amateur photographs. In this department there are six exhibitors in the hygiene group; three in surgical apparatus; six in primary, secondary, and superior education; about thirty in literature, books, journalism, etc. It was in this group that was included the Stratford-on-Avon house of the *Illustrated News*, but this fine exhibit has been withdrawn. We have about twenty exhibitors of instruments of precision, cameras, lanterns, etc., and it is well to see the names of Grubb, Ross, Watson, Baker, and Beck in this group.

Really great things may be expected from the Fine Arts Desheriff of the City of London, and myself fell the honor of first representing the Commission, and Sir Edward Birkbeck and Sir Douglas Galton are shortly expected in Chicago. Sir Philip Cunliffe-Owen, whose name is known and honored throughout America, was to have accompanied us, but at the last moment he was struck down with illness.

It has been my peculiar privilege to be closely associated with the Columbian Exposition from its inception, probably more closely in an honorary sense than any other foreigner, and the success of the undertaking as a whole is a matter that I have very much at heart. I can of my own knowledge testify that Chicago earnestly desired the fullest coöperation of England; she gave her throughout the best locations, the fullest advantages, the greatest space that could be afforded. If we have not seen fit to avail ourselves of our opportunities, the fault is ours, not theirs, and I cannot help feeling that, if facts had been more forcibly brought home to our manufacturers,—if for example our newspapers had shown a broader and more unanimous spirit than they have done,—Great Britain would have taken her proper place at the head, and far in advance, of all other foreign nations. The individual spirit of kindness and good will in England towards America is not wanting (though perhaps it lies somewhat below the surface), as I have had ample occasion to ascertain in my private and not unsuccessful efforts to form a loan collection of objects connected with transportation, for my friend Mr. Willard A. Smith of the Transportation Exhibits Building, and the royal interest taken in the great celebration at Jackson Park is proved by the fact that Mr. Walter H. Harris has been intrusted with a fine series of Windsor tapestries as a loan to America. In this connection I may add that Mr. Harris is offering to Mr. Higinbotham, the president, as a loan, his splendid, indeed almost unique, collection of British war medals.

THE LATEST AND GREATEST CUNARDER.

By a Clyde Engineer.

BY the time this Magazine is in the hands of its readers the new Cunard liner *Campania* will have arrived at New York, and much will doubtless have been written in the daily press about her performances on trial as well as on the Atlantic. That she is the embodiment of the most advanced practice in marine construction is universally admitted, and, although I am at the time of writing unable to prophesy her performance on the Atlantic, I may hazard the remark that she has surprises yet in store for the public.[*] As in the human system, so with the marine engine, a little training makes the joints supple. Thus it is that no steamer has broken the record in its maiden transatlantic trip. It is true the *America* did excel all previous performances in her first voyage, but it was on the way back to England after she had had a week of training on the Atlantic in addition to the trial cruises. The *Campania's* engines have power in reserve to create surprises. And here the remark suggests itself that the machinery of the *Campania*—as of all steamers—is her most interesting feature. Without the engines she would indeed be lifeless,—beautiful as the conception of Venus by a master mind, but still inanimate.

The engines of the *Campania* and of her consort *Lucania*—names, by the way, taken from the old provinces of ancient Italy—are of the five-cylinder, triple-compound type first introduced into the North German Lloyd steamer *Lahn*, also built at Fairfield, and now fitted for the first time into twin-screw steamers. The advantage is that great power may be developed without an unduly large low-pressure cylinder. Thus in the *Campania* over 30,000 horse-power has been indicated, and yet the low-pressure cylinders are each only 98 inches in diameter. There are two high-pressure cylinders of 37 inches diameter, one intermediate cylinder of 79 inches, and two low-pressure cylinders of diameter above named, the stroke in each case being 69 inches. The high-pressure cylinders are placed above the low-pressure cylinders with the ordinary sleeve

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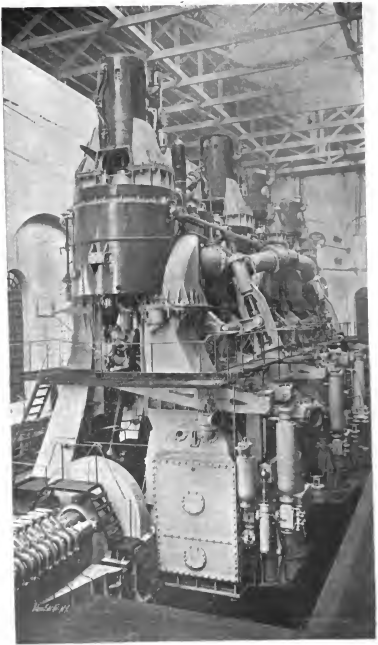
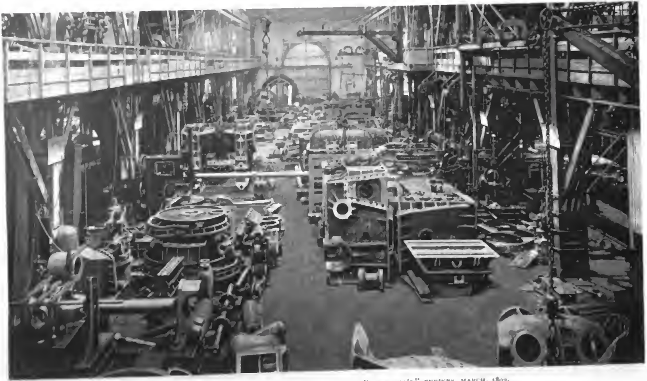
[*] This paper was written in Glasgow before the *Campania* started on her first transatlantic voyage. An account of the record made will be found this month in the department of "Mechanics."—THE EDITOR.

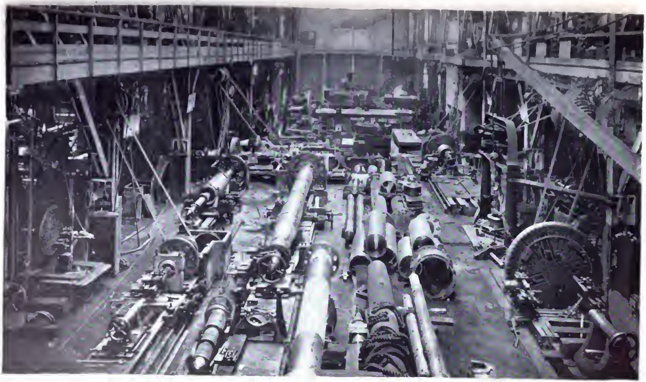

TWIN ENGINES OF THE "CAMPANIA" AS COMPLETED.

stuffing-box, the intermediate is between the pairs. This arrangement will be comprehended from the engraving of the engines completed, shown on another page. The engines were finished in a remarkably short space of time. The order was not given till August, 1891, and yet all the details of design for the machinery had been arranged by Mr. Andrew Laing, the engineering director at Fairfield, patterns made, and the first of the castings and forgings delivered in the machine-shop before the end of September. Before the close of the year the bed-plate, frames, condensers, and the three-throw crank-shaft of one of the engines were erected in position in the fitting-shop. There were lively times at Fairfield at the beginning of 1892. All the immense machine-tools were in active operation; and here it is interesting to note that much of the work was milled with tools designed on the principle of those largely in use in American works. The condition of the machine-shop at the end of March was significant of industry, and two of the engravings accompanying this paper are views from opposite ends at this time. Immense cranks weighing 27 tons; 24-feet lengths of 26-inch propeller shafting; huge cylinder liners; valves; piston rods; connecting-rods; and eccentrics of something like five feet in diameter lie about like,—well, like scraps of paper on the floor of an editor's room. Yet a careful examination suggests evidences of system, without which the work could not have been advanced so speedily.

About this time, too, the two engines of the *Campania* were in a forward condition. Everything was ready for placing the cylinders in position, the connecting-rods lying loose to join up to the cross-head, while the air-pumps were completed and in place. The thrust-shaft was also in its bearings. Three months later, or at the end of June, the two engines were completed, for at this time the photograph reproduced on page 289 was taken. Nor was this despatch at the expense of other work, for the engines of the *Lucania* were well in hand, ready for the placing of the condensers, while at the same time the establishment was completing the engines of another twin-screw steamer for the channel and a 19½-knot paddle-steamer. In fact, there was in June last, on the floor of the fitting-out shop at Fairfield, engines which aggregated something like 70,000 indicated horse-power, probably excelling the total in any other works at one time. This, apart even from the long list of successes in engine design, testifies to the efficiency of Mr. Laing's management. His skill and aptitude as a designer



MACHINE-SHOP AT FAIRFIELD, DURING CONSTRUCTION OF "CAMPANIA'S" ENGINES, MARCH, 1892.

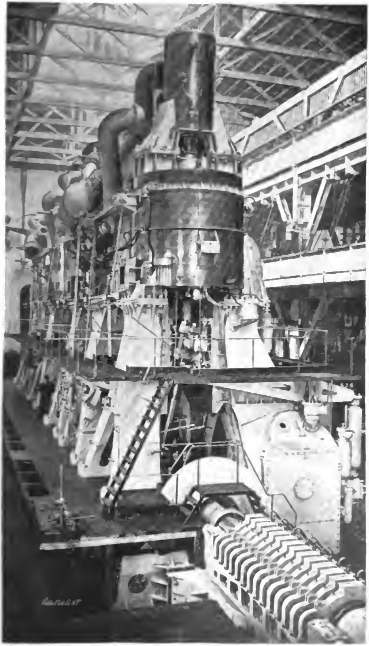


MACHINE-SHOP AT FAIRFIELD DURING CONSTRUCTION OF "CAMPANIA'S" ENGINES, MARCH, 1892.

have been acquired by long experience at Fairfield, where he has been since 1877, and where for the past thirteen years he has been responsible for the design of engines for all types of steamers and war-cruisers, built at the Fairfield company's famous establishment at Glasgow.

The engines which Mr. Laing has not only designed and constructed, but has tended during their first task of bringing the leviathan across the Atlantic, stand 47 feet high. A piston-valve is fitted to each of the high-pressure engines, and slide-valves to each of the others, one valve gear being the usual double eccentric and link-motion. The condenser is in three parts, and is divided into two sections, each low-pressure cylinder exhausting into different sections. The circulating pumps are worked independently and the engine for driving them is of the compound type; but it is so arranged that it may be worked as a high-pressure engine,—both cylinders getting steam direct from one boiler,—so as to develop a higher power for bilging out. The air-pumps are worked as is usual by levers from the crossheads of the forward and aft engines. The crank-shaft is in three interchangeable parts, set at the usual angles, each part weighing 27 tons; and with the thrust-shaft, which is 14 feet long, the crank-shaft weighs in all 110 tons. There are 14 rings of the ordinary horseshoe type tied direct to the foundation of the engine. The propeller shaft is 26 inches in diameter, and the three blades of each screw are of manganese bronze, each weighing 8 tons. The stern of the vessel has been bossed out so that outside shafting has been dispensed with, the shaft being carried right aft inside with a bearing close up to the propeller. This arrangement is seen on the engraving of the stern of the vessel. Every safeguard against possible contingencies has been provided, and among these may be noted emergency-gear fitted in connection with the steam and hydraulic starting and reversing engine, whereby the engines are automatically stopped when they exceed a given number of revolutions, determined according to what is regarded as the limit of safety. Before adoption the efficiency of this gear was thoroughly tested; and since it was fitted it has been worked with most satisfactory results.

There are fourteen boilers in the *Campania*, having in all 102 furnaces. Twelve of these are of great size, the largest made to work at 165 pounds pressure, or even higher pressure. Some of the plates worked into them measured 20 by 7 feet and were over 1½ inches in thickness. The twelve large boilers are double-ended,



TWIN ENGINES OF THE "CAMPANIA" AS COMPLETED.

18 feet in diameter by 17 long, each with eight furnaces. There is a combustion chamber common to each pair of furnaces. One of the smaller boilers is for auxiliary machinery, and the smallest for donkey purposes; but all may be used for propelling the vessel, if desired. The boilers are shown in a group in one of the engravings. In the ship they occupy two large water-tight compartments separated by a large compartment given over to the carrying of fuel. This bunker is 60 feet long and the entire width of the ship, so that when the vessel comes to be used as an armed cruiser by the British admiralty, for which purpose she gets an annual subvention, she will not only have great speed and seaworthiness in her favor, but long coal endurance. There are two funnels about 130 feet apart. Great as is the ship, the enormous diameter and height of these funnels are impressive. The diameter is 20 feet and the height from the base of the ship 130 feet. Sufficient draught is thus provided.

Unlike most of the other high-speed modern Atlantic liners, neither the *Campania* nor the *Lucania* has a forced blast to assist consumption. The stokehold is open, and only the stoker who has had one day's experience in the Gulf stream in August can appreciate the blessing of this arrangement. To still further insure free ventilation there have been provided a large number of fans working on the shade deck. The necessity of these was established owing to the openings in the stokehold being somewhat restricted to provide the requisite passenger accommodation; for, as we have already stated, the machinery occupies the best part of the ship and nearly one-half of the length. The feature of the fans is that they are driven by a new type of triple-compound engine. Each engine contains two cylinders, into which a piston having three distinct areas is placed in such a way that triple expansion is carried out in the cylinders while the pressures on the crank shaft are entirely in one direction. Weir's system of feed-heating is installed. The economy of this system, introduced many years ago, is now established, and the rationale may be briefly stated thus: the quantity of steam condensed by the feed-water represents an amount of steam which has been worked in a theoretically perfect engine, because after doing work the whole remaining heat, both latent and specific, is returned to the boiler.* Pumps and evaporators have also been fitted. The steam-pipes are of wrought-iron lap-welded; and in this departure Mr. Laing has acted with care,

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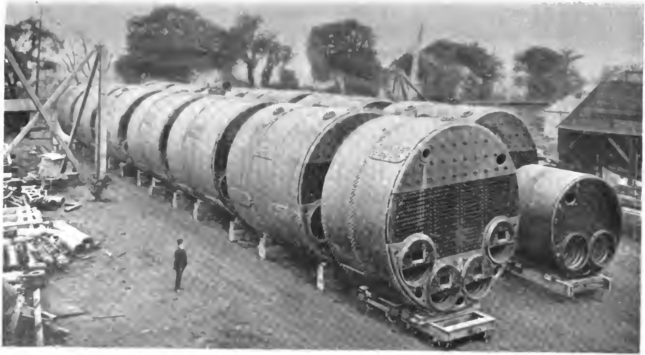
* See *Engineering*, Vol. IV., p. 527.



COMPLETE SET OF BOILERS OF THE "CAMPANIA."

but with characteristic energy. He had many tests made,* and found that a pipe 11¼ inches bore and of metal $\frac{13}{16}$ inches thick showed no movement, although 800 pounds pressure was applied, and did not finally burst until subjected to 3100 pounds. The pipes in the Cunard vessel are of twenty inches bore, and of $\frac{9}{16}$ inches metal.

The electric-light generating plant is placed in the main engine-rooms, which, by the way, are separated by fore and aft bulkheads. There are four engines and dynamos,—two in each compartment,—and these run 1350 lights, the current being passed from a large switchboard through about fifty miles of wire laid on the return-conductor system, in connection with Siemens's distributing-box. Any two of the dynamos are sufficient to completely illumine the ship. Each engine is designed for an output of 70 brake horse-power when running at 275 revolutions per minute, and with 100 pounds steam pressure. A notable feature in the design is that the balance piston-valve is placed centrally between the two cylinders and admits and exhausts steam from both cylinders. The governor balls are controlled by springs, and the gear is arranged to operate the single eccentric directly. As there is only one slide

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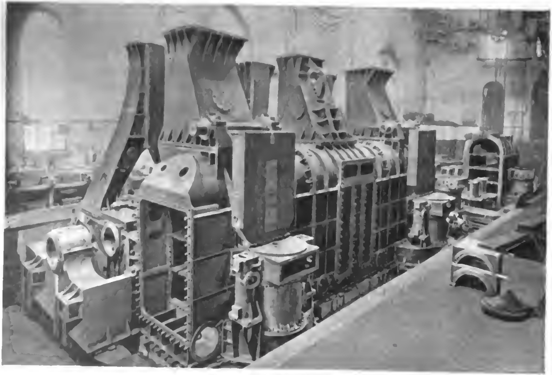
* See *Engineering*, Vol. LII., p. 519.

VIEW OF THE "CAMPANIA" ON THE DAY OF THE LAUNCH.



ENGINES OF THE "CAMPANIA" IN FITTING-SHOP, DECEMBER, 1891.

valve, the power in the high-pressure and low-pressure cylinders is practically equalized at all loads, which is unattainable when the governor acts only on the high pressure slide-valve. The dynamos are Siemens's high-pressure type, having drum armatures, each dynamo giving an output of 420 amperes, under 100 volts pressure, at 275 revolutions. Throughout the ship the 16-cylinder pressure unit is retained, and the number of lamps, rather than the illuminating power, increased where desirable.

The hull, while extraordinarily strongly constructed in all respects, has been specially strengthened in the wake of the machin-

THE "CAMPANIA" UNDER STEAM.

ery. The 4 feet 6-inches plate which forms, with its angular booms and stiffeners, the center line-girder of the vessel, has been increased in depth to 7 feet 6 inches at the machinery, and the two similar girders on either side at 15 feet centers are all increased in depth and weight. These five girders form the flooring of the ship and have between them intercostals. There is a double bottom, the outer being riveted to the bottoms and the inner to the upper edges of these girders. Both skins are, of course, thoroughly water-tight, so that, should the vessel founder, her inner bottom would prevent the inrush of water to the interior. Besides, the space between the two floors may be utilized for carrying water ballast for trimming purposes. Sixteen hundred tons of water may be thus carried. This water, too, may be pumped in as the vessel proceeds on her voyage, if necessary to counteract the reduction in coal carried, so that the immersion of the vessel may be retained at the most satisfactory draught for high speed. The necessity for this will be appreciated when it is stated that the vessel may burn over 2000 tons of coal in a trip across the Atlantic, and will be lightened to this extent on the voyage. From the outside girders,

ANDREW LAING.[*]

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[*] Mr. Andrew Laing, manager of the engine-works and also a director of the company, has been at Fairfield since 1867, and has taken an intimate and creditable part in many of the triumphs in marine construction at that point. Indeed he has since 1881—the date of his appointment as chief draughtsman—been responsible for the design of all the notable steamers built at Fairfield for the Atlantic, Eastern, and other services. With such experience it became a relatively easy matter to determine all details of design to suit the requirements laid down by the directors of the Cunard Company.

forming the base, there rise the side frames which are of the channel section, with web frames at frequent intervals, carrying the hull beams for the six decks, and the transverse bulkheads dividing the ship into sixteen or eighteen watertight compartments, so spaced that three of them, particularly those forward, might be flooded without the vessel sinking, while any two flooded would cause only inconvenience. The largest compartments are those for the boilers and engines. The shell-plates are of great size; the minimum is 25 feet by 6 feet breadth. They are scarfed under the waterline and belted and strapped above.

Although not our intention to enter into details regarding the design of the ship and the thousand-and-one little conveniences introduced by the designer, Mr. R. Saxton White, it may be interesting to mention one or two of the principal features by way of preface to our description of the machinery. As is now so well known by all who take an interest in Atlantic steamers, the length of the *Campania* is 622 feet long over all, or 600 feet between perpendiculars, 65 feet in beam, and 59 feet in depth from shade deck. There are six decks,—top, lower, main, upper, promenade, and shade. The first-class passengers are accommodated in the center of the ship, the best state-rooms being on the promenade and upper decks. There are *en-suite* rooms, one-berth, two-berth, and three-berth rooms. The ordinary rooms are on the upper and main decks, with a few even on the lower deck. The second-class rooms are located on the same deck aft of the machinery, with the poop for promenade. The public rooms are all sumptuously decorated and of great size. The dining-saloon accommodates from 500 to 600 persons. It is on the main deck with an immense well to the shade deck—about 35 feet high—for ventilation and light. The drawing-room, library, and smoking-room are on the promenade deck.

The steering-engine is entirely under water. With the exception of the American liners *Paris* and *New York*, the *Campania* and *Lucania* are the only merchant vessels of which this can be said in the truest sense of the word. The stern of the *Campania*, just above the rudder, has an annular chamber, which in outward appearance is not unlike a torpedo launching-tube. It is shown in the engraving of the stern of the vessel. From this chamber are connecting rods from the 4-feet crosshead of the rudder. These rods are 20 feet long and connect with Brown's steam-tiller steering-gear. The rudder-head is turned by means of a cast-steel tiller 17 feet long, having at its after end a double jaw fitted with bearings, and carrying between the jaws a pinion running in a horizontal plane and engaging with a toothed quadrant bolted to the deck. The steering engine is carried on the tiller and moved round with it, receiving and exhausting steam through a double stuffing-box arrangement mounted on the axis of the tiller. All the machinery involved is a bronze worm-wheel connected by an internally expanding friction-clutch with spring relieving-gear to a steel pinion about 18 inches in diameter, working in a cast-steel segmental curved rack about 13 feet radius on the pitch-line. Auxiliary engines worked on somewhat the same principles are provided. They are geared up by cast-steel gearing with pitch wheel and chain which lays hold of the tiller. The great power of the windlass may be assumed when we state that the engine for working it indicates 600 horse-power. Only the hoods, which are of 5 tons weight, are above the forecastle deck. De La Vergne's refrigerating system has been fitted for the provision-rooms, and Kilbourn's system for the cargo-holds. Altogether, as stated at the outset, the vessel is most carefully designed and as carefully built, reflecting credit on all concerned.

F. SAXTON WHITE.*

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*Mr. White, who was installed as manager of the shipbuilding department of the Fairfield Shipbuilding and Engineering Co., Limited, in 1887, with a seat at the directors' board, had a training eminently fitting him for undertaking the designing and construction of great ships. He had previously been engaged successively in the works of Messrs. Denny, Napier, Sir William G. Armstrong, Mitchell & Co., and the Barrow Shipbuilding Co., being intimately associated with the designing of ships as well as the management of the various works.

EVOLUTION OF THE IRON-FOUNDER'S ART.

By Simpson Bolland.

THE term "founding" is applied by many persons to all processes connected with the manufacture of articles in metal, whether the finished product has been forged from the malleable metal or cast in molds. This generalization is entirely misleading, and it has made all the more difficult the work of placing the origin of iron-founding as an art. Iron-founding, in its proper sense, is the art of preparing molds from plastic materials of such a nature as will successfully resist the intense heat of the molten iron,—as loam or sand,—in which may be formed the object to be produced in iron, the process being completed when the iron has been melted, run into the mold, and permitted to solidify.

Of the antiquity of working in brass and iron, as well as the more precious metals, there is abundant evidence, including mentions of the subject in the earliest books of the Bible. That the iron of the Hebrew records was not cast-iron is made to appear with much significance in Isaiah xlviii, 4 (supposed to be about 700 B. C.): "Because I know thou art obstinate, and thy neck is an iron sinew,"—the latter word being a plain indication of the quality of toughness common to iron in a malleable condition. Further evidence in support of this hypothesis is found in Psalms cvii, 16—"For He hath broken the gates of brass and cut the bars of iron asunder." A marked distinction is here observed in the methods of spoliation; if the iron had not been malleable, there would have been no necessity for the cutting. Some knowledge of smelting iron must have been known to the ancients; otherwise neither Tubal-Cain nor his Hebrew successors could have accomplished the forged-iron work with which they are credited.

An ancient method of smelting, still employed by the natives of India, is very simple and effective, probably the same as that used by the Israelites during their term of bondage in Egypt. On the whole, it is probable that, while malleable iron was in common use among the ancients, they were practically unacquainted with cast-iron and its uses; and it is more than probable that the mention of iron sculpture by the Greek writers referred to objects which had been beaten out by hammering, and not cast in molds, as was the case, undoubtedly, in their bronze work,—the antiquity of the art of casting in bronze and the precious metals being well established. The processes employed were probably similar to the *cire-perdue* process.*

Much stress is laid on the statement of Pausanius (A. D. 120) that Theodorus the Samian was the first to discover the art of casting in iron and making statues of it, about 440 B. C.; if he was, the secret must have died with him, there being no evidence of the art at that time, extending beyond his island home in the Mediterranean. We must confess that the state of the mechanic arts then existing do not harmonize with probability in Pausanius's statement; because to mold statues in cast-iron would have demanded a knowledge of materials and a degree of skill very superior to and much more exacting than that to which statue-founders had hitherto been accustomed in the *cire-perdue* processes no doubt then prevalent. But further on he says, "To make statues of iron is most difficult and laborious," from which we are almost tempted to believe that the noble islander did accomplish something of the kind, after all, and left the world no wiser as to the methods he pursued.

As time advanced, a growing demand for implements of war, as well as for the more peaceful implements of agriculture and other domestic arts, created the necessity for improved systems of producing malleable iron for such purposes. But about the early part of the sixteenth century larger furnaces for the manufacture of cast- or pig iron were introduced in some parts of Europe, such iron being subsequently converted into malleable or wrought iron in the forge-hearth.

A patent was granted in England about the year 1544 for a new process of making cast-iron, but works written much later than this date make no mention of castings being made from this metal; which seems strange when it is certain that castings had been made from the earliest ages from other metals and their alloys. About 1740, we are informed, iron cannon were successfully cast in the south of England by workmen who were afterwards taken across the channel to teach the Frenchmen this new art. At this time there wère very few furnaces that would produce more than one ton of pig-iron per day; consequently, where the foundry

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***Cire perdue* (literally, lost wax).—A French term applied to the process of bronze casting wherein the article to be cast is first modeled in wax; the wax model being then inclosed in plastic clay, upon heating which the wax melts and runs out, leaving the mold.

operations were of more than ordinary magnitude, a number of these miniature blast-furnaces might have been seen at work together.

Reaumer, the great French metallurgist, published in 1722 an interesting account of the methods then practised by him. The remelting of the pig-iron had previously been conducted in crucibles, but he conceived the idea of facilitating foundry operations by melting his metal in direct contact with the fuel, using for this purpose what may be taken as the forerunner of the cupola at present in use. A shaft was provided which fitted the top of the crucible, into which the iron and fuel were charged at the top in alternate layers; the blast, produced by two large blacksmith's bellows, was forced in at the lower end of the shaft, and maintained at a vigorous rate until the requisite quantity of iron was melted, after which the shaft was removed, the debris cleared away, and the crucible, containing the molten iron, was emptied into the molds. From this we may date the beginning of modern foundry methods.

It was not till after Reaumer's death, in 1757, that these primitive cupolas came into anything like general use, though the itinerant founders of his day evidently were not slow to discover their practicability as portable furnaces. He thus ingeniously describes these tinker-founders: "There are founders who do nothing every day but to melt cast-iron and no other metal. Their number is not large, and I do not know whether there are more than one or two in Paris. These founders travel through the country, and make their appearance gradually in different provinces. They make cast-iron weights, plates for different purposes, cast new, and patch old, hollow-ware. These founders buy the pig-iron they want from peddlers, who gather cast-iron scrap in the villages in the vicinity of Paris. This scrap is exchanged for apples; a man with scales in one hand, leading a horse laden with poor fruit, does the business, exchanging apples for iron, weight for weight."

The "Philosophical Transactions" of the Royal Society of London for 1747, reviewing the art of making cast-iron with pit-coal, and casting articles therefrom—something which had been taking place, secretly, at the foundry of Abraham Darby, Colebrookdale, England, from 1713—speaks of it as a curiosity. This enterprising gentleman hailed from Bristol, having leased the iron-works at Colebrookdale in the year 1707, when it consisted of a single small furnace and foundry. Before locating at Colebrookdale Mr. Darby had engaged, as an apprentice, a young Welsh shepherd named John Thomas, who accompanied his master and worked in the foundry. The lad observing the ineffectual attempts of a Dutch molder thought he saw the reasons for the man's failure, and was allowed to try his hand, the result being that with the assistance of his master an iron pot was successfully cast. A secret agreement was entered into between the two to keep the secret, which was loyally kept on the part of the boy, who was ever the friend of his master's family when, in after life, they were sorely tried. The great secret of the whole process consisted in effectually leading away the gases generated in the core when the molten iron entered the mold, which, if left confined, must inevitably burst the core and thus spoil the cast. Simple as this may seem at this day, the knowledge of making such casts in iron was so limited at that time that they were enabled to keep their secret for almost a century afterwards.

Abraham Darby died, 1717, when his new enterprise was in a flourishing condition, and was succeeded by his son, who was named after him, and it was through the indefatigable exertions of the latter that coke, instead of charcoal, was finally used in smelting, about the year 1760. Iron-founding received an impetus at this period of its history such as it had never before experienced. The steam-engine of Watt, coming into use at this time, developed the iron manufactures at a wonderful rate, as by its means blast power was increased, and all rude contrivances, as blacksmith's bellows, and rotary machines driven by horses or oxen, which had been employed for creating blast in furnaces, were gradually abandoned in favor of the blowing engines driven by steam.

Castings in iron for the early engines of Watt and Boulton were made at Colebrookdale, as were also those for the first cast-iron bridge, which was erected over the Severn, close to the works, by the third Abraham Darby, and opened for traffic in 1779. To meet the growing demands of this newly awakened industry the Darby firm had soon to open other works at Ketley and Horsehay, and branches of the same firm were established at Liverpool and Bristol; also, agencies for the disposal of machinery, manufactured by this firm for mining purposes, were opened at Truro and Newcastle. The renown of this pioneer foundry has spread throughout the world; their reputation as manufacturers of modern machinery is only equaled by their perhaps greater renown as producers of the highest class art work of every description in cast-iron and bronze. The days of long ago are still forcibly indicated by relics which are still treasured with the greatest care, although the works, generally, are for the greater part modern in arrangement and equipment. An old furnace may be seen on supporting beams, dated "1658," and three others have "Abraham Darby 1777" inscribed on them. One old foundry has a plate over the door with "1774" on it, and they still retain possession of the old cylinder, 4 inches diameter and about 36 inches stroke, which originally belonged to Trevethick's first locomotive.

We can conceive of the difficulties attending the early efforts of our forefathers in the manipulation of such castings as were needed by the pioneer engineers, whose demand for fine iron castings would steadily increase as the practicability of steam power became manifest. About the year 1769 steam was universally recognized as the chief motive power, and was gradually applied to all descriptions of machinery. No doubt failure often resulted when trials were first made on castings of the nature required. All this new work had to be done by molders, who, necessarily without knowledge of the nature of materials, must grope their way with absolutely nothing but hard and inexorable experience to guide them. Under such adverse circumstances there was no other way to success but hard endeavor; if a casting was bad, it was necessary to try again, and again if need be, hoping to discover the cause of failure and avoid next time the errors of preceding trials arising from ignorance of first principles. It is a lamentable fact that, although a century has since passed, the rank and file of molders are to-day working on the same indefinite lines.

The change from castings of a very ordinary type to the superior kinds required for steam- and blowing-engines, as well as machinery of all descriptions, which at this time was being rapidly changed from wood to iron, must have been almost bewildering, as nearly all parts of the engine, including crank, connecting-rod, and beam, were then made in cast-iron, of elaborate design and intricate in the extreme. Good molders must certainly have been everywhere in great demand, especially such as were able to make castings that must of necessity be made in loam and dry sand. Examples of high-class molding were set in those early days, which, with very few exceptions, have abided with us, unaltered, to this day.

About this time, the old devices for manufacturing woolen and cotton goods were supplanted by Arkwright's "throstle" and

Crompton's spinning mule, which in time were built up almost exclusively of cast-iron. Wooden bridges began to disappear in all directions, and cast iron structures were erected in their stead. The great Henry Cort, of Gosport, England, invented a method of rolling iron instead of hammering (1783), and from this event a demand for still another class of heavy castings was inaugurated; while later on, about 1807, paddles were introduced for the propulsion of ships, which called for superior castings suitable for marine engines. Subsequently, about 1836, the screw propeller usurped, to some extent, the unwieldy paddle, and, with the advent of this remarkable device, arose the finest example of molding yet seen. That the iron founders of the past were invariably equal to the occasion is eminently proved by the casting of the screw propeller, which to this day is molded after plans discovered by our predecessors during the early days of steamboating. The advent of hydraulic machinery caused a demand for castings of such magnitude as to make the erection of special plants for the production of this class of work an absolute necessity. Improvements in agricultural and textile industries also demanded the erection of massive foundries.

Up to thirty years ago very few of the improved methods of molding now practised had been introduced in the foundries; nor had any one competent foundryman or engineer attempted to supplant the cumbrous and ungainly equipments of the past by the very elegant and efficacious appliances now found in mammoth model foundries. The ponderous and slow wooden cranes have, by a gradual process of evolution, merged into machines of wonderful efficacy, and are now almost automatically controlled. The overhead trolley for conveying molten iron direct from the cupola to every part of the foundry is an improvement on the old system of hand-carrying necessitated by the magnitude of some foundries in which the distance from the cupola to the furthermost parts of the shop is great; and, where such devices cannot be applied conveniently, we see well kept tracks with switches in every available direction, on which handy trucks, specially constructed for this purpose, are used for conveying, with ease and despatch, every material used in foundry operations. For the time-honored wheelbarrows has been substituted the conveyor, which hauls everything to its destination entirely clear of the foundry floor. Where once all the iron and fuel were carried by hand to the cupola scaffold, we have now, in some places at least, elegant provision of either electric, steam, or hydraulic appliances for performing this work. The old rule-of-thumb methods of charging the cupola have at last given place to the more sensible and economical system of weighing all material in correct proportion. Attention has been given to many minor things also. We have seen even the riddle superseded first by the common upright screen and then by the swinging and sliding machine riddles, and now the revolving screen is to be seen in many foundries. Cleansing mills, provided with an exhauster to carry off the dust, have superseded the primitive method of scrubbing sand off the castings with stone and wire brush. Loam mills of infinite variety and degrees of effectiveness are to be seen, where once the click of the chopper was to be heard. Some of the modes devised for clamping together the flasks, seen now almost everywhere, are ingenious in the extreme, and it is pleasing to observe how common at this time is Nasmyth's great invention, the geared ladle. Once it was thought that hay and straw rope must always be twisted in the primitive fashion; but this also has yielded to the spirit of invention, and the rope-spinning machine is throwing off bands, well spun and true. Machines too numerous to mention have been invented during the past thirty years, which, without the aid of a costly pattern, will make either spur, bevel, miter, mortice, or worm wheels. The extraordinary progress of the cast-iron pipe industry, with reference to equipment, has been such as to make that branch of molding almost independent of skilled labor. The same may be said of many other classes of work where large quantities of duplicate castings are in demand, such work being now produced in the several molding-machines with a facility and dispatch impossible by the old methods of ramming by hand.

The invention of plaster blocks paved the way for the improved systems of plate molding which immediately succeeded them, introducing the interchangeable modes of flask pairing and the earlier kinds of stripping plates, the latter principle constituting the chief element of success in the modern molding-machine.

One of the greatest aids to modern founding is the system of tests, chemical and physical, to which, in some firms, the pig-iron is subjected before it is charged into the cupola. When eminent chemists inform us that whatever quality of iron the iron-founder demands can be furnished by the furnace manager, it would seem that it only remains for the foundryman to acquire such chemical knowledge as will enable him to know the exact measure of every element needed to produce the desired quality of iron, and thus, by chemical analysis, determine all his mixtures. Keep's tests are no doubt the most comprehensive of any of the physical tests for this purpose which have yet appeared, as they embrace every element necessary for discovering the nature and quality of cast-iron.

At present we seem to be on the eve of great changes; and it is somewhat difficult and hazardous to predict the channels which future progress in iron-founding will take. Owing to the system of dividing labor, now becoming so prevalent, it is simply impossible for the ordinary workman to master the details of founding; this, coupled with general lack of education, leaves him, in a measure, incompetent to manage even ordinary establishments intelligently; but how utterly incompetent are such men for becoming heads of the magnificently-equipped foundries now being constructed. To operate such establishments it has been thought advisable, by some, to change the order somewhat, and engage the services of an educated engineer, so that the efforts of the foreman molder shall be directed in paths which run in harmony with known physical laws.

When so much has been accomplished by the uneducated founder in the past, what are we entitled to expect in the future from this added intelligence? Time will show. The age is pregnant with ideas. The full blaze of scientific knowledge is lighting up dark and hitherto mysterious nooks in which nature has hidden many precious secrets. To suppose that the useful and noble art of iron-founding will not share in the riches thus lavishly obtained would be to rank it as among the least progressive of the mechanic arts; whereas recent advances show that it is no longer wedded to ancient ideas and methods, but is eager to embrace any and all sound improvement.

The consideration of the possibilities in foundry practice forces itself upon the attention of practical men who now thoroughly understand these possibilities. Indifference is giving way to active research and investigation, with reference to the supply of suitable material and equipment. Schools of technology will yet be brought to see the importance of giving the foundry more substantial recognition. One of the best modern molding machines owes its origin to experiments, conducted by its inventor, in the foundry of the Stevens' Institute,—a fact which might be profitably borne in mind by the faculties of other technical schools, which, as a rule, are woefully deficient in means for teaching the art of founding.

The introduction of some late inventions for melting iron indicates the march of progress in this particular very forcibly. Every effort is now put forth to prevent the immense waste of heat which occurs in ordinary cupola melting, by a disposition of the tuyeres such as will burn the ascending combustible gases without heating the fuel to incandescence, in which instance the developed heat pre-heats the iron and fuel before it reaches the melting zone. What may we not expect in the prevention of heat-waste, when we find that electricity has at last been successfully applied for melting cast-iron? It is claimed for the "Taussig" electric system of melting cast-iron in exhausted chambers that oxidation and creation of air bubbles are avoided, and that the cost for driving the dynamos is 50 per cent. less than would ordinarily be required for melting by the best practice.

The advent of the chemist in the foundry marks a new era in iron founding, and is perhaps the surest indication of a desire for thorough advancement, as, by his aid, the indecision and doubt hitherto existing must ultimately cease. Mixing of different brands of cast-iron, as well as the alloying of cast-iron with other metals, to obtain a higher degree of homogeneity, or any other special quality in the resultant casting, will, under such qualified direction, be more easy of accomplishment.

Given superior direction, we may confidently anticipate the time when, by the united efforts of the scholar and the trained artisan, the art of iron-founding, in neither equipment nor skill, shall be second to any of the iron industries.

THE TRANS-SIBERIAN RAILWAY.

By Frederic Hobart.

THE longest railway in the world would possess a certain interest from its length alone; and when to that are added the facts that it will open up a greater extent of undeveloped country than is included in the entire continent of Europe, and that engineering difficulties of a peculiar kind are to be overcome in its construction, the line is invested with an importance which should make its location and description worth some study. The details given here in relation to the great Trans-Siberian railway are based upon official reports, and the location described is that made after careful preliminary surveys and finally approved by the Russian government. It may be added that the work of construction has been fairly begun, and that the largest ironworks in that country are busy on the material required.

The work of providing a route across Siberia was committed to the charge of the ministry of public communications—at that time under Mr. Possiet—nearly ten years ago. The expense of the construction of a railway over so great a distance appeared to the minister too heavy to be undertaken, and the first plan proposed was for a mixed rail and water-line. In outline, this plan provided for an extension of the Oural railway to the town of Toumen on the Toura, whence boats can pass by the Toura, Tobol, Irtish, and Obi rivers to Tomsk, the chief commercial city of western Siberia; a railway from Tomsk to Irkoutsk, 1130 miles; a water route by the Angara and Lake Baikal to some point on the eastern shore of that lake; another railway of about 750 miles thence to the head of navigation on the Amour; some 1600 miles of boat line on that stream; and finally a railroad from the river south to the port of Vladivostok.

The survey of the line from Tomsk to Irkoutsk was placed under the charge of Colonel N. P. Mejeninov, one of the most eminent of Russian engineers and a man who is accustomed to take clearer and broader views than most of his associates. He saw, and very strongly urged in his report, the uselessness of building over a thousand miles of road which would be practically isolated for two-thirds of the year, and expressed a most decided opinion in favor of an all-rail line as the only one which would meet the needs of the country.

This report was practically unanswerable in its reasons ; but it was laid aside, and no action was taken until 1886, when the czar himself, his attention having been aroused by a report from General Count Ignatieff, then governor of eastern Siberia, called for all the papers bearing upon the subject. Struck by Colonel Mejeninov's report, he adopted his views and personally ordered General Hubenett, who had then recently succeeded Mr. Possiet as minister, to direct the immediate survey and location of a continuous line at least as far as the Amour. Later he went still further and ordered the construction of the entire line from the Oural mountains to the Pacific. The czar's interest in the road has been shown by many orders and decrees, and by the fact that he sent his son, the czarevitch, especially to Vladivostok, to give greater *éclat* to the formal opening of work on the Pacific end of the road.

The final survey and location was begun in earnest in 1888. Colonel Mejeninov was at the head of the work and himself undertook the location of the central section, from Tomsk to Irkoutsk, while Colonel Viazemski took charge of the trans-Baikal section and Major Oursatti of the Pacific end. These were completed in 1891, but the location of the western section to Tomsk was not finished until 1892, and the final work on the survey of the Amour valley line is still incomplete, although enough has been done to determine its general course. And it will be finished during the present summer.

While this work was in progress, the connecting link between the Siberian line and the railway system of European Russia was completed. This alone was a considerable undertaking, the road being 605 miles long. Starting from Samara on the Volga, it runs for 300 miles, to Oufa, across the plains drained by that river and its tributaries. From Oufa to Zlatooust, 200 miles, it passes through the rough and broken country west of the Ourals ; east of Zlatooust it crosses the main chain through the Sirostan pass, ending at Chelabinsk, which, though beyond the geographical boundary, is still politically in European Russia. This town, the starting point of the Siberian line, is on the Mias river at the edge of the great steppe which stretches eastward to the water shed of the Yenesei, and northward to the Arctic sea.

The czar having finally directed in 1891 that an all-rail line should be built, the work was at once begun. A Commission of

Engineers, appointed to examine the surveys, approved the location; the road was divided into six sections, on each of which a commencement has been made. These sections would be best described in detail, taking each in its order from west to east. It will be of interest to American engineers to know that their practice has been studied by the Russian engineers and largely followed in location. American methods will be used in construction also, but the equipment of the road will be designed to correspond with that generally in use on the Russian railways.

The river crossings will be the most difficult of the engineering works. Siberia is a country of large rivers, and some of them present especial obstacles to bridge-construction. Most of them run from south to north, the result being that the ice breaks up first in their upper waters. Ice-gorges and heavy, long-continued spring floods are the rule, while the great weight and thickness of the ice make necessary the reduction to a minimum of the obstructions to the waterway, so that few piers and long spans will be the rule in these structures. The design of the important bridges is under the charge of Professor N. A. Beleloubskoi, who is regarded as a leader among Russian bridge-engineers. Among the great bridges will be those over the Ishim, 700 feet in length; the Tobol, 1400 feet; the Irtish, 2100 feet; the Obi, 2800 feet; and the Yenesei, the longest of all, with fourteen spans of 350 feet. All these will be of iron or steel; but for the smaller streams many bridges will be built of wood, generally of the Howe-truss pattern.

To take up again the sections of the road in their geographical order, the first is the western section, which will be 1080 miles long, from the starting-point at Chelabinsk to the junction with the central section at Pochitanka. For 880 miles the line crosses the great steppe, a high, level plateau, with no marked divides or water-sheds between the rivers. The location here is almost an ideal one; it follows nearly the 55th parallel of latitude, the only deviations being to secure the best points for crossing the larger rivers, which have generally cut deep channels in the alluvial plain. There are few small water-courses, and the directness of the line may be judged when it is stated that there will be tangents respectively 50, 62, and 86 miles long, and that the road as located is only 2½ per cent. longer than an air-line.

For nearly 600 miles this steppe is an excellent agricultural country, and, though now very thinly inhabited, is well adapted for wheat, rye, and other small grains. The climate, however, is not an easy one; the summers are warm but short, and the winters severe. At Omsk, a central point, the mean temperature of the six winter months is about 1° F.; the thermometer frequently falls to 40° and even 50° below zero; the snow-fall is heavy, and long-continued northerly winds are common.

For the 300 miles towards the eastern edge of the steppe it is thickly strewn with small lakes, in many of which the water is either salt or alkaline. Much of the land is barren, but much is wooded, and cattle are raised in considerable numbers, thriving on the grass of the salt marshes which abound. For the 200 miles east of the Obi river the road will pass through a more difficult country, hilly, heavily wooded, and intersected by many small rivers. To avoid difficulties in location it was decided to reach the important commercial city of Tomsk by a branch.

The central Siberian line, the second section of the great road, accordingly does not begin at Pochitanka, but 82 miles west of it, at Tomsk, the administrative and commercial capital of central Siberia; this division is 1048 miles long, extending to Irkoutsk, and in one of the more difficult sections of the road. For nearly a quarter of the distance, from Tomsk to Achinsk, it is a line of easy grades, rising gradually through a wide plain intersected everywhere by the upper tributaries of the Obi. While the grading is light, however, this part of the line will be notable for the number of river crossings. No less than forty bridges of over 200 feet in length will be needed, beside a great number of smaller ones.

Just east of Achinsk, and 260 miles from Tomsk, the line enters the Cremia-Ishikin mountains, a series of abrupt, but not very lofty, wooded hills which mark the water-shed between the broad steppes watered by the Obi and its tributaries and the deep valley of the Yenesei. Careful location was needed to avoid heavy work here, and for 115 miles the line will follow a tortuous course to Krasnoiarsk, where it will cross the Yenesei on the great bridge already mentioned. From this point eastward 355 miles to Nijni-Oudinsk there is encountered a succession of rivers flowing through valleys separated by high ridges, and this long section will require many deep cuts and long fills. For 158 miles further, to Oukhtouisk, the general character of the country is the same, but the divides are lower and less difficult. At Oukhtouisk the road enters the valley of the Balaia, and following that river and the Angara has a comparatively level course for the remaining 164 miles to Irkoutsk.

The Angara is a notable stream. The outlet of the "Lake of Death," as it has been called, the great Lake Baikal, is a wide, deep, and rapid river, frozen for two-thirds of the year and in the remaining third subject to quick floods, for which no one has ever been able to assign a cause.

The country along the central Siberian division is not populous. Much of it is heavily wooded on the hills, but low and swampy in the valleys, and not attractive to the settler. The railway follows quite closely the line of the great highway which has been the main line of travel ever since the Russians penetrated the Baikal region. For many years the caravans and freight-sledges from Kiakhta have followed this road, and their business has built up a few small towns; but outside of these there are only some nomad herdsmen in the whole region. There is little doubt, however, that there are coal deposits in the Kainsk foot-hills; iron ore is found and worked in a small way in the charcoal forges at Mariinsk and one or two other places, and it is not improbable that, when the road is in operation, this region may be the seat of an important mineral industry.

At Irkoutsk begins the third section, known as the Baikal loop, which is the shortest but most difficult of the whole line. In the five months when they are free from ice the deep, sullen waters of Lake Baikal are treacherous and unsafe, so subject to disturbance by violent gales that no reliance can be placed on their navigation, and it was apparent that the road must be carried past the lake in some way. Many preliminary lines were run, and it was only after long consideration that Colonel Viazemski finally recommended a location. The division is 194 miles in length, but its cost will be heavy, even with a ruling grade of 2 per cent. and the sharpest curves allowed on the road. From Irkoutsk the line runs southward along the Irkout river, following the many windings of the stream, mainly in side-hill cuttings in heavy clay, for 60 miles; then turns sharply eastward into a pass in the Zirkizoun range, which it will cross through a tunnel 12,500 feet long, at a height of 770 feet above the lake. The eastern slope of the mountain is followed until the line strikes the southern point of Lake Baikal at Koultouk; thence it keeps closely to the shore of the lake to Misovskaia.

No city in the world, probably, has a wider range of temperature than Irkoutsk, where in summer 98° F. is not uncommon, while in winter the thermometer registers from 50° to 65° below zero. The Baikal region is a high plateau, open to the north, remote from the tempering influences of the sea, and its climate is that which might be expected under these circumstances.

At Misovskaia begins the trans-Baikal section, 663 miles long, which will carry the road into the region whose waters are tributary to the Pacific. Briefly described, this section runs for 60 miles along the shore of the lake and through the valley of the Selenga to the town of Verkhne-Oudinsk, the oldest in the trans Baikal. From this point there is no doubt, although it is not yet located, that a branch will run up the Selenga some 75 miles to Kiakhta, that strange double frontier town where for many years the business between Russia and China has been exchanged, and from which the great sledge-trains start yearly on their long, slow journey westward. This traffic will be a considerable item for the railway.

From Verkhne-Oudinsk the main line runs eastward through the valley of the Ouda, rising gradually toward its headwaters, until, about midway in the division, it encounters the barrier of the Jablonnovoi mountains, the highest in eastern Siberia. Here no less than fourteen of the mountain passes were examined before a location was made. The line adopted crosses the foot hills into the upper water-shed of the Lena, then recrosses the main range by the Shoidak pass at a height of 3700 feet above sea-level,—the highest point on the road,—and descends through several small river valleys into that of the Shilka, the chief western tributary of the Amour, which it follows to the head of navigation at Sretensk.

On this section materials of construction abound and the work is not heavy, except for a few miles through the Shoidak Pass. The trans-Baikal is the rich mineral section of Siberia. Iron ore abounds in the Jablonnovoi range, and there are gold, silver, and copper deposits which are already worked in a very limited way, but which can be largely developed when the railroad reaches them. The winters there are intensely cold, but the air is dry and the snowfall very light. Agriculture does not exist, but in the wooded valleys large herds of cattle and horses are raised by the nomad Toungoos tribes.

The Amour section, from Sretensk through the valley of the Amour to Grafskaia, is the longest and will probably be the easiest on the line. The distance is 1600 miles, and the line is not yet fully located, but the preliminary surveys show but slight difficulties to be surmounted. The Amour country is justly regarded as the garden of Siberia. The river valleys are fertile and well watered, timber abounds, and the climate is much less severe than in central and eastern Siberia, tempered by the vicinity of the sea, and in some measure protected by mountain ranges from the Arctic winds. Population alone is needed, and comes but slowly, in spite of the efforts made by the government to encourage free immigration from European Russia. There are few or no convicts in the country, the trans-Baikal having so far been the limit of deportation from the west.

What is known as the Oussouri section is the last in order. It runs from Grafskaia southward through the valley of the Oussouri, a tributary of the Amour, breaks through the hills at its headwaters by a long, deep cutting and two tunnels, 700 and 1100 feet long, into the valley at the southern end of which lies Vladivostok, the Russian port and naval station on the Pacific. This division, though the last named, was the first on which work was actually begun. Formally opened by the czarevitch nearly two years ago, more than half the grading of this section was completed early in the present year, and some 50 miles of track laid. The Oussouri peninsula has valuable deposits of coal, which are already worked to some extent, while other coal fields and deposits of copper, iron, and lead will be reached by a branch line of 200 miles, which has been located to Khabarovka, the capital of the province.

The whole length of the main Siberian line is 4700 miles, and its estimated cost $196,000,000. The line, with branches, will cover 5000 miles to be built by an expenditure of $200,000,000. The present program provides for the completion of the main line to Krasnoiarsk in 1896 and to Irkoutsk in 1899, and of the entire road in 1904, but whether this can be fully carried out is somewhat doubtful. Conceding the financial ability of Russia, the main difficulty will be found in the supply of labor.

It should be mentioned that the estimate given is for a line with steam ferries at the four or five great river crossings, where bridges would add $5,000,000 or more to the estimated cost.

It is reasonably certain that Vladivostok will not be the permanent Pacific terminus. That port is too far north and is not a sufficiently convenient harbor for the purpose. There is no doubt that a secret but careful reconnoissance has been made of the Korean ports, and that one of them will be the terminus as soon as the time is ripe for its acquisition by diplomacy or force. Of course nothing is said about this openly as yet, but the purpose exists and the plan will be carried out in due time.

As to the commercial importance of the Siberian railway there may be different opinions. The steppes of western Siberia are susceptible of settlement and cultivation, and may add a considerable area to the wheat fields which compete with those of America. The river valleys of the Amour region are also capable of cultivation and may in time support a large population, while the Oussouri country is known to be rich in coal and iron. The long stretch of over 1500 miles from Tomsk to the headwaters of the Amour, however, can never have much local traffic. The climate and soil alike forbid settlement, and a small business in horses and cattle from the nomad herds and in lumber from the forests of the Irtish and the western trans Baikal, with the supply of the mining regions on the slopes of the Jablonnovoï, will be the most that can be expected. Through commercial traffic to the Pacific cannot be large, though the Chinese trade will be an item of considerable importance on the western half of the line, and is a traffic capable of development with the facilities which could be furnished by the proposed railroad. With all allowances for growth, however, it is safe to say that, if the road is regarded simply as an investment for capital, its commercial prospects would not warrant its construction for very many years to come.

The main purpose of the line is not commercial, however, but military and political. The Trans Caspian Railway has consolidated and made permanent the Russian power in Central Asia, and its extension to Khokand and Tashkend, now well under way, will make an excellent supply line for an army invading China from the West. The Siberian line on the other side will be a base line for operations from the North and East, and the ancient empire will be placed at a serious disadvantage. The shrewdest of the Chinese statesmen are aware of this, and their efforts to strengthen their northern frontier are in contrast to the supineness of the English, who seem now, as usual, to rely altogether on their naval force to check the designs of their great rival in the east.

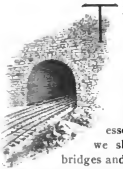
It is undoubtedly a perception of these possibilities which has made the project a favorite one in the Imperial circle, and brought about the conditions necessary to secure its early execution. The official order calls for the completion of the entire road in 1904; and while it seems hardly possible that the work can be completed in ten years with the means at hand, there is little doubt that the opening decade of the twentieth century will see the completion of the first Trans-Asiatic railroad.

ENGLISH AND AMERICAN RAILWAYS.

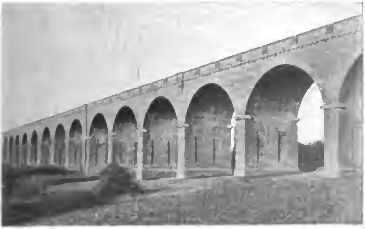
A COMPARISON AND A CONTRAST.

By William M. Acworth.

THIRD PAPER.



THE preceding papers in this series having contained a summary of what seem to me the most important points of difference between English and American railways, in what follows I propose to illustrate the characteristic practice of our railways by a series of pictures typical as far as may be of their different features. The first and most essential part of a railway is the road itself, so we shall do well to begin with illustrations of bridges and viaducts. Those given hereafter are all on the line of a single company, the Midland, the bulk of them on the line between Liverpool and London, which many American readers will know as the most picturesque, though not the shortest, route between these two cities. They explain themselves, but



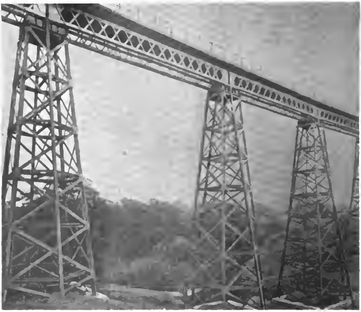
MIDLAND RAILWAY—HARRINGTON VIADUCT.

[Eighty-two arches, each 40 feet span.]

MIDLAND RAILWAY— RUGBY VIADUCT.

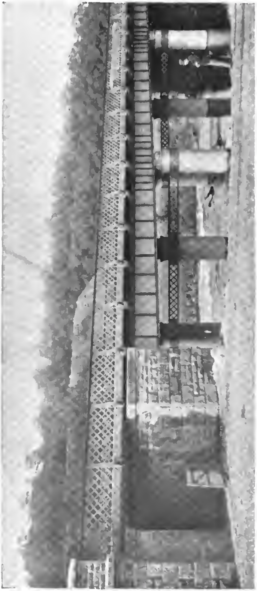
[More than fifty years old.]

perhaps I may add, as showing that English railway-works have been of the most solid possible character from the very outset, that



MIDLAND RAILWAY—DOWERY DELL VIADUCT.

the viaduct over the Avon at Rugby—11 arches of 50 feet span—was opened in 1839, while the Harringworth viaduct—82 arches of 40 feet span—was only built some thirteen years back. The unprecedented incursion of American ideas displayed in the Dowery Dell viaduct on the Halesowen branch may be explained by the fact that the line, though now worked by the Midland, belongs to, and was constructed by, a small and impecunious independent company. The illustration of a Sunday morning's work, relaying the line at Wickwar near Bristol, may serve as a sample of the method in which the permanent way is laid. The picture of the water-troughs on the main line of the Northwestern will



MIDLAND RAILWAY, MANCHESTER TO LONDON—WHATSTANDWELL BRIDGE.

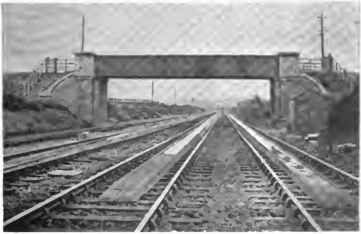
also be useful for this purpose, while not a few of the remaining illustrations will afford incidental glimpses of English railway structures.

Next there is a series of pictures of stations. Broad street, in the heart of the city of London, belongs to the Northwestern. The land on which it stands cost $300,000 an acre, and is probably worth twice that sum to-day. This station deals with a vast miscellaneous traffic in valuable freight; tea and dry-goods, wool and silk, are shipped, and fish and meat received, in enormous quantities. A feature of this station is the "Field," now roofed over, but open when my picture was taken two or three years back. In the background goods-wagons are shown while being raised on hydraulic lifts. Liverpool-street station is the terminus of the Great Eastern, which serves the working-class districts of the East end of London, and carries over 80,000,000 passengers per annum. Bishopsgate is a station half a mile further down this

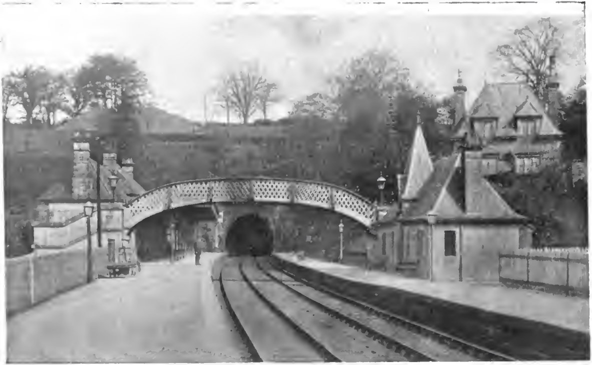
MIDLAND RAILWAY—RELAYING THE LINE.

same line. The Waterloo terminus of the London and Southwestern has a suburban traffic as dense, reckoned in number of trains,—about 700 *per diem*,—as Liverpool street. Its passengers are not so numerous, but being of a much higher social class, and consequently traveling largely "first" instead of "third," they require more room per head than the Great Eastern workmen. Waterloo station itself is a ramshackle place enough. Originally built in 1848, it has been patched and added to at frequent intervals ever since. But the brand-new signal-box, which stands astride of the entrance to it, is perhaps, with its 242 levers of the latest design, with its elaborate electric control of every movement, and with its staff of ten men, the most perfect signal installation in the world. As such it well deserves reproduction here.

For illustrations of country stations I have thought it well to go to the Lancashire and Yorkshire, one of the most remarkable lines in the world, though visitors to England are not very likely to come into contact with it. The Lancashire and Yorkshire Company is entirely confined to the two counties whose name it bears, but it serves every part of the densely populated district between Leeds and Liverpool. It has not more than some 520 miles of line, but while only fourteen of those miles are single, between thirty and forty are quadruple, and the rest double. The capital of the company is about $250.000,000 ; it has over 1000 engines and nearly



LONDON AND NORTHWESTERN—WATER-TROUGHS.



MIDLAND RAILWAY, MANCHESTER TO LONDON—CROMFORD STATION.

4000 passenger-vehicles, while its 520 miles are divided into over 700 block-sections. From this line, whose operating department is a model of excellence, I give illustrations of some typical stations: Daisy Hill, a roadside station between Liverpool and Manchester; Rochdale, an important junction; and lastly Blackpool, probably the greatest excursion center in the world. At certain times of the year the inhabitants of Lancashire cotton towns simply migrate *en masse* to the seaside; and Blackpool thinks it nothing out of the common to receive fifty excursion trains before 11 o'clock in the morning. A picture of the locomotive-works of the same company, the Midland, at Derby,* will suffice to illustrate another side of English railway construction. Perhaps, too, as most of our great lines have docks and steamships of their own, I ought to add Parkeston quay, near Harwich, the property of the Great Eastern, to illustrate railway buildings of a very different kind.

PARKESTON QUAY, NEAR HARWICH.
[Great Eastern railway passenger station and hotel to the left.]

But it is time to turn from buildings to rolling-stock. English express passenger-engines are of two main types. That which will

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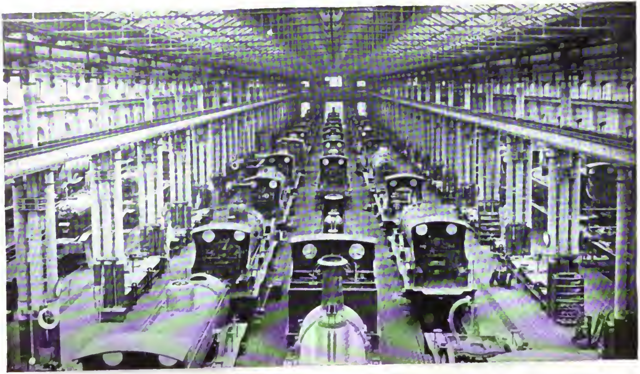
* The great English companies all build their own locomotives and carriages, and only have recourse to private firms in time of exceptional pressure.

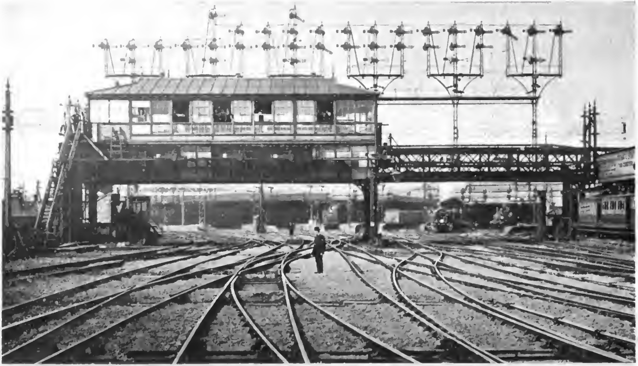


MIDLAND RAILWAY LOCOMOTIVE-WORKS, DERBY—THE NEW ERECTING SHOP.

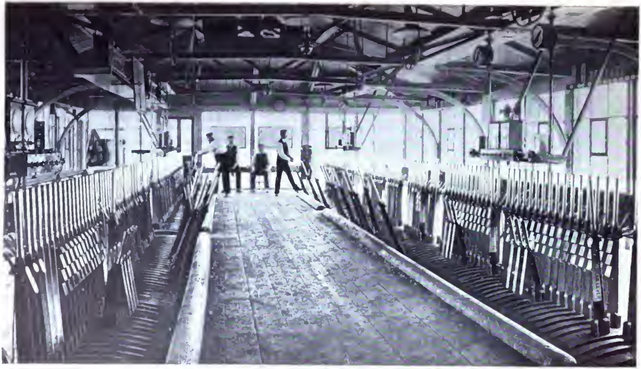
LANCASHIRE AND YORKSHIRE—DAISY HILL STATION.

be most familiar to readers in the new world is what you would call the "American" type, with four drivers coupled and a swiveling truck (which we call a "bogie") in front. Of this type I give illustrations of a Midland and Caledonian engine, both as used for the fastest and heavy iest trains, and a Caledonian engine, somewhat smaller, used for working the expresses between Glasgow and the summer resorts on the Firth of Clyde. The "Greater Britain"

DAISY HILL STATION, FROM WIGAN END.



LONDON AND SOUTHWESTERN RAILWAY, "A" BOX, WATERLOO—WROUGHT-IRON SIGNALS.

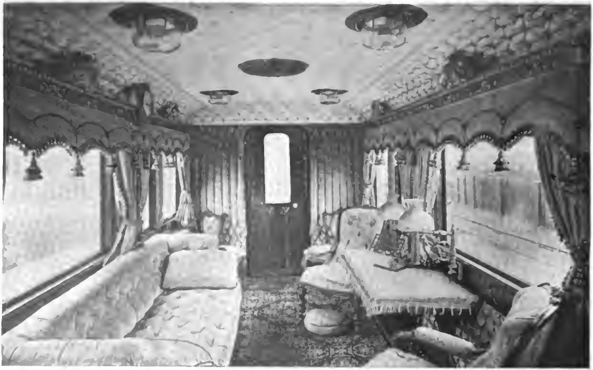


LONDON AND SOUTHWESTERN, "A" BOX, WATERLOO—242 LEVER-LOCKING APPARATUS.

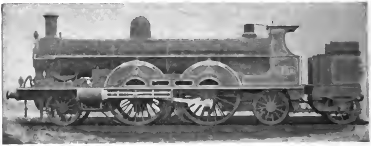
LANCASHIRE AND YORKSHIRE—ROCHDALE STATION.

of the London and Northwestern deserves special notice, though it cannot be said to be typical of normal English practice. This is a three-cylinder compound on Mr. Webb's system, with two high-pressure outside cylinders, 15 inches diameter, driving the trailing-wheels, and one low-pressure cylinder inside under the smokebox, 30 inches diameter, driving the leading wheels. It will be noticed that this engine has an exceptionally long boiler, and that both pairs of drivers are in front of the fire-box. The boiler-tubes (which in English practice are almost universally copper) are therefore divided into two lengths by a combustion chamber, the back group being 5 feet 10 inches long, while those between the cham-

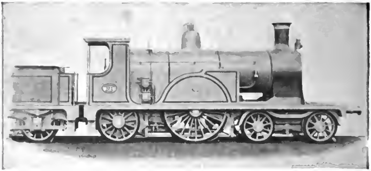
GREAT WESTERN RAILWAY—CORRIDOR TRAIN.



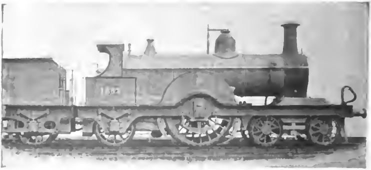
LONDON AND NORTHWESTERN—INTERIOR OF THE QUEEN'S DAY SALOON.



"GREATER BRITAIN" LOCOMOTIVE—3292.

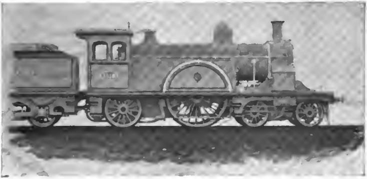


CALEDONIAN RAILWAY—LOCOMOTIVE "123."



MIDLAND RAILWAY—LOCOMOTIVE "1853."

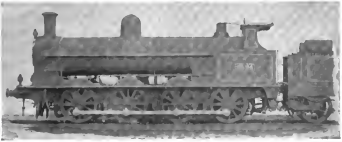
ber and the smoke-box are 10 feet 1 inch in length. The working pressure of steam is 175 pounds, and the total weight of engine and tender in working order 77 tons 2 cwt. I give likewise a picture



NORTHEASTERN RAILWAY—LOCOMOTIVE 1518.

of a new Northwestern goods-engine. It also has an extra long boiler and a combustion chamber and runs on 8 coupled wheels. The universal English goods-engine is identical with the above in appearance except that it has only six wheels in all, instead of eight.

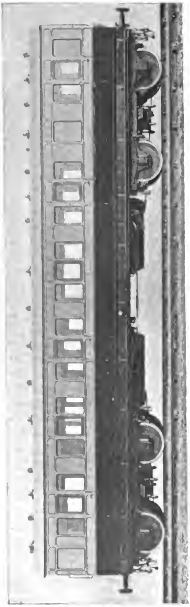
But the typical English locomotive is the express-engine with single drivers. The famous Great Northern engines, which are now a quarter of a century old, are entitled to lead the way. They will take a train of 120 tons at 60 miles an hour with consumption of less than 23 pounds of coal per mile. In consequence of the unusual height of the cranks they have outside cylinders, while the accepted English practice is to put the cylinders inside. It will be noticed also that they have no steam-driver. An engine nearly twenty years younger than the Great Northern singles, but not less famous, is No. 123 of the Caledonian railway, built, however, not by the company, but by a private firm, Messrs. Neilson & Co.



NORTHWESTERN RAILWAY GOODS-ENGINE.

This was the engine which, in the "Race to Edinburgh" in the summer of 1888, repeatedly ran the hundred miles from Carlisle to Edinburgh over a very heavy road in from 100 to 104 minutes. No. 1853 is a Midland engine which won a gold medal at the Paris exhibition.

The Midland road is by no means an easy one, yet these engines will take trains weighing 160 and 170 tons at 50 miles an hour booked speed with a consumption of coal seldom rising above 26 or 27 pounds per mile.* And that they do their work with consummate ease I can testify from personal experience. I was on one of them one day with the Nottingham express, timed to run 124 miles in 145 minutes, and we came in 5 minutes in front of time, though for the last 10 miles there had only been enough steam on to lift the weight of the motion off the slide-bars. Lastly let me mention what is probably the biggest engine in Great Britain, the two-cylinder compound (Worsdell and von Borries system) of the Northeastern railway. The cylinders are



LONDON AND SOUTHWESTERN RAILWAY—"AMERICAN EAGLE" EXPRESS.

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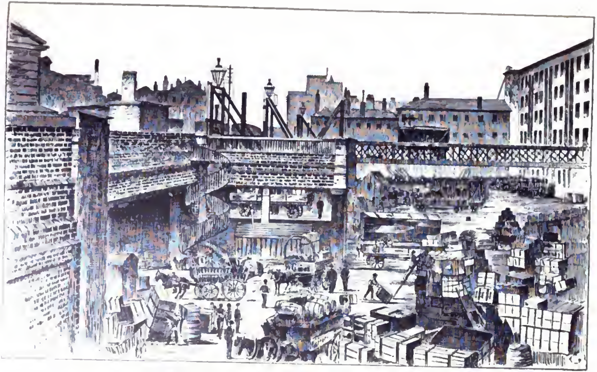
* Individual engines have been known to work under an average of 19 pounds for a week.



LONDON AND NORTHWESTERN RAILWAY—BROAD-STREET STATION—THE "FIELD."

20 and 25 inches x 24-inch stroke, pressure 175 pounds, driving wheels 7 feet 7½ inches, total weight 86 tons 14 cwt. This engine has taken a train of 270 tons * 67 miles in 78 minutes. It will be noticed that, alone of English engines, it has a "cab" something like an American one. It will be noticed also that all the "single" engines shown, except the Great Northern one, have steam sanding apparatus. Finally it may be said that English tenders have always six wheels and a rigid wheel base.

Lastly we come to carriages; and, as in duty bound, I begin with the Queen's day saloon on the Northwestern railway. This carriage is, it will be seen, small and antiquated; but the Queen has grown accustomed to it and refuses to allow it to be either replaced or modernized. There is a sleeping-saloon of similar size and construction, which usually accompanies it. Her Majesty travels, it will be observed, on six rigid wheels; nor, as English road-beds are kept in first-class order, and the speed of her train is limited to about 35 miles an hour, does she suffer much by doing so. But the rest of her subjects find "bogies" run easier, and eight-wheel stock is becoming the accepted pattern for main-line trains. Of this a West Coast "sleeper," showing that even in our sleep we preserve our insular prejudices in favor of "lonesome, stuffy compartments," furnishes one illustration. On the other hand two pictures of old and new Great Eastern carriages, first-class and third-class respectively, show that for ordinary local travel standards have varied but little in the last quarter of a century. Lastly a series of pictures of two new trains, the "corridor train" on the Great Western, and (which should interest American readers) the "American Eagle express," between London and Southampton, show tentative approximations to the practice of the United States. In the latter train it will be observed that each carriage is disconnected. In the former there is connection throughout the whole length, but the doors between the carriages are locked,—a precaution which it seems impossible to dispense with as long as three different classes of passengers are carried on the train and there are no conductors or car-porters available to exact extra fares from those who change from a lower to a higher class in the course of their journey.

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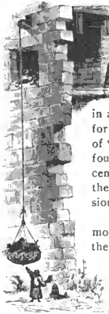
* English tons are always gross tons of 2240 pounds. The American ton of 2000 pounds is entirely unknown here.

THE AMERICAN PASSENGER ELEVATOR.

By Thomas E. Brown, Jr. 9



THE ORIGINAL PASSENGER ELEVATOR.

[From an old print.]

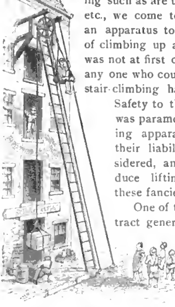
THE most noticeable feature in the recent growth of the large cities in the United States has been the advent of tall buildings. They occupy oftentimes but a small surface area, but they tower upward in an apparently reckless manner that has gained for them the not altogether incongruous cognomen of "sky-scrapers." Especially are these buildings found in those portions of a city adjacent to a central point,—congested localities around which the greatest interests in the financial and professional world are bound to congregate.

The nearer the approach to the center, so much more valuable is the area or space occupied; hence the utilization of every square foot of land to place one above the other as many business and professional men as the science and art of building construction can conveniently shelter from the weather. Not only is this ambition of the land-owner or capitalist to reach the clouds confined to business quarters, but in the most desirable residence streets people prefer to be removed some distance vertically from terra firma, rather than be at a lateral distance of several miles from the best points for business. The result has been a complete metamorphosis in the character not only of external architecture, but also of interior construction.

Few persons, even in the architectural or constructional professions, have paused to realize fully how entirely this change of conditions is due to the evolution and perfection of the American passenger elevator. It is this perfection of the lifting service, both in regard to speed and safety, that has altered the restful and classic lines of the architecture of a past age,—that pleasing distribution of mass over a large area,—and in its place substituted a veritable tower treatment of design where the object is greatest economy,—namely, the largest percentage of net return upon the original investment.

As each successive building exceeded its neighbor in altitude by a number of feet, it soon became evident that an economical height had been reached, as the necessary increased thickness of walls and foundations sacrificed more space below than was gained above, to say nothing of the enormous increase in cost. Here the radical departure was made from old-time methods; the walls of a building were no longer required to support the floors, but became merely a shelter from the elements, the steel-ribbed tower interiors being self-supporting, capable of carrying all loads, and also lending their stability to what was required for a suitable outside appearance.

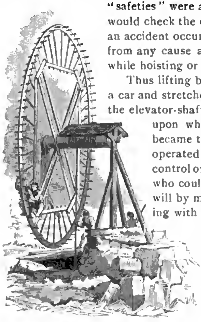
In view of such radical changes, the development of the primary means which rendered these changes effectual, and therefore necessary, must be of considerable general interest. Putting aside all the crude mechanisms for hoisting such as are used in mine-shafts, stone-quarries, etc., we come to the early passenger elevator,—an apparatus to save people the time and fatigue of climbing up and down stairs. Time, however, was not at first considered, it being supposed that any one who could afford to forego the fatigue of stair-climbing had ample time at his disposal. Safety to the person of the vertical traveler was paramount, and therefore ordinary hoisting apparatuses with suspended ropes and their liability to breakage could not be considered, and hence efforts were made to produce lifting machines which should avoid these fancied dangers.



AN EARLY TYPE OF ELEVATOR.

One of the first passenger elevators to attract general attention was one placed in the Fifth Avenue hotel, New York, about thirty years ago. This consisted of a long vertical screw in the elevator-shaft extending through its entire height, and turned by a steam engine in the cellar, the screw working through a nut attached to the elevator-car, the car and nut being prevented from also turning by guides; the nut and car were therefore forced upward or let down according to the direction in which the screw was revolved. This machine was slow and inefficient, expensive in operation, and difficult to keep in repair. These defects caused the abandonment of this type of elevator, and inventors reluctantly reverted to the use of ropes and turned their attention to the development of safety devices to prevent accident in the event of their breaking; these "safeties" were automatic contrivances which would check the descent of the car should such an accident occur, or stop the engine should it from any cause attain an undue speed, either while hoisting or lowering.

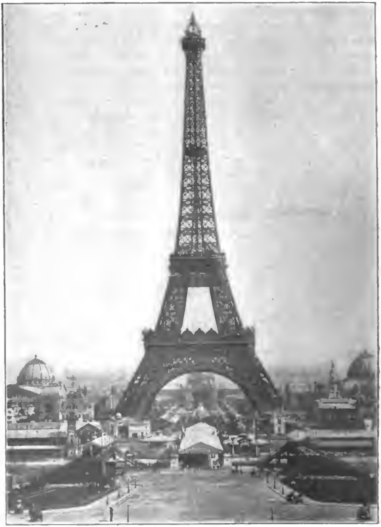
Thus lifting by ropes attached to the top of a car and stretched over pulleys at the top of the elevator-shaft, thence downward to a drum upon which they wound or unwound, became the next step. This drum was operated by a steam-engine, under the control of the attendant in the elevator, who could start, stop, or reverse it at will by means of a hand-rope connecting with the valve of the engine. A good example of this early steam passenger hoist was in operation as long ago as 1866, in the St. James hotel, New York, where a double-oscillating engine was placed in the bottom of the shaft to operate the winding drum.



A MAN-POWER ELEVATOR.

The steam passenger elevator came into very general use, and was developed to a high degree of perfection, but these elevators were slow and wasteful of power, and the machinery by its nature produced unpleasant pulsations and vibrations in the car, and, upon the invention of the hydraulic elevator, the steam elevator was rapidly abandoned for passenger service and relegated to factories and warehouses, for the lifting of heavy freight.

One of the earliest forms of hydraulic or water elevator consisted of a sheet-iron bucket attached to the ends of cables which,



THE EIFFEL TOWER.

[Each of the four legs of the tower contains an elevator. These differ from ordinary elevators in that they follow the curve of the tower legs instead of moving vertically. Two of these elevators are of American construction. A fifth elevator, traveling vertically, is used from the intermediate to the top landing.]

after passing over pulleys at the top of the building, were attached to the elevator-car, the bucket weighing a trifle less than the car. The whole was controlled by powerful brakes acting on the guides or rails upon which the car moved, and a reservoir on top of the building supplied by a steam-pump served as the source of power. When the bucket was empty, the car would descend if the brakes were released, and, when the bucket was filled, the car would ascend. These elevators were capable of very high speed, often attaining a rate of 1800 feet per minute, but, not being subject to automatic control, they were soon abandoned, though one remained in use in the Western Union building, in New York, until it was recently destroyed by fire.

PUBLIC ELEVATOR AT BAHIA, BRAZIL.

[Communicating between the upper and lower towns.]

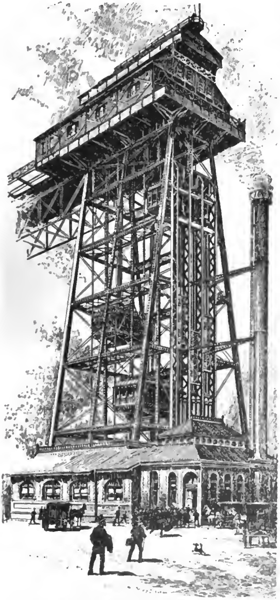
In Europe, owing to the prejudice against suspending elevators by cables, which were considered dangerous, and the total lack of faith in safety devices, the direct ram type of elevator came generally into use. In this type the car is placed on top of a plunger working in a cylinder, for which a pit must be excavated in the earth, as deep as the building is high, and, while this type apparently possessed all the elements of safety, its installation required

VIADUCT AND ELEVATORS AT WEEHAWKEN, N. J.

[The main tower, in the foreground, contains three hydraulic elevators which are the largest, for passenger service, in the world, and are used to convey passengers from the ground to the railway station above. Each has a capacity for 150 persons and makes the trip of about 150 feet in 40 seconds.

a large outlay entirely disproportionate in many cases to the value of the elevator service. As in this country the height of buildings rapidly increased, keeping pace with the improvements made in elevator appliances, the practical possibilities of the direct ram type were soon outstripped. Few examples can now be found in America, though many are still in use in Europe, where buildings as a rule are not so lofty.

These, however, are rapidly giving way to the American type, large numbers of which are anually shipped to Europe, as well as to other parts of the world, and to-day elevators built by New York makers will be found, not only in the European countries, but also in China, Japan, India, Egypt, New Zealand, South America, and in large numbers in Australia. The introduction of the American type, or suspended lift, in London has already shown its effect in the increased height of new buildings designed with reference to its application.



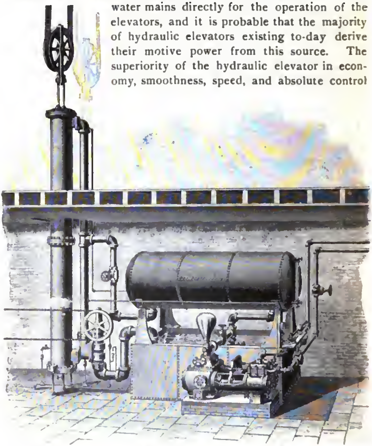
THE WEEHAWKEN ELEVATORS.

From "Harper's Weekly" by permission; Copyright, 1891, by Harper & Bros.

An effort was made some years ago to retain the supposed advantages of the direct ram elevator, and avoid the expense and disadvantages attending the digging of the deep pit. This effort resulted in the production of what was called the telescopic elevator, in which the car was supported on sliding tubes, one fitting in the other similar to the tubes of an ordinary telescope or marine glass. Elevators of this type were used in the New York

Post-office, but, on account of their inefficiency and the difficulty of keeping them water-tight, were soon abandoned.

The hydraulic elevator first came into general use from the fact that most cities possessed waterworks operated under considerable pressure, and it was found practicable to utilize this pressure in the water mains directly for the operation of the elevators, and it is probable that the majority of hydraulic elevators existing to-day derive their motive power from this source. The superiority of the hydraulic elevator in economy, smoothness, speed, and absolute control so soon manifested itself that even in cities where water under pressure was not available large pumping-systems were installed in buildings for the sole purpose of operating elevators. Some of these water-power systems in large buildings have a capacity



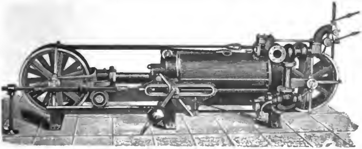
HYDRAULIC ELEVATOR CYLINDER, WITH PUMPS AND PRESSURE-TANK IN BASEMENT.

larger than the water-supply systems of many good-sized towns.

In some cities of England—notably London and Liverpool—waterworks are installed, and many miles of pipes laid in the streets, whose only purpose is the operation of elevators, hydraulic cranes, and similar machinery, and for which service consumers pay at certain rates per gallon of water used, much the same as we in this country pay for gas and electricity. In these systems water is furnished under a pressure of about 700 pounds per square inch.

When the placing of independent pumping-systems for elevators in buildings first came into use, it was usual to place an open reservoir on the roof, the elevators operating under the pressure due to the height of the building; but as the requirements of elevator service became greater, necessitating higher pressures, it was found that but few buildings were of sufficient height to give the pressure required, and hence the system now usually adopted of increasing the pressure due to the height of the building by using closed tanks containing compressed air came into general use; and in cases of low buildings, where the height was not sufficient to give material assistance, such closed tanks were often placed in the basement. The hydraulic elevator of to-day, though made by many different manufacturers, each having a preference for some particular detail of his own, is essentially the same in all cases, superiority of one make over another being simply a question of excellence of design and workmanship.

All such machines consist of a hydraulic cylinder, placed either vertically in the elevator shaft, or horizontally upon the floor of the basement, and varying in diameter and length according to the de-



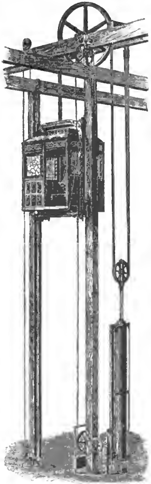
HORIZONTAL HYDRAULIC ELEVATOR CYLINDER.

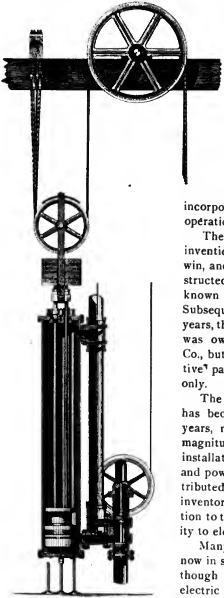
[Showing multiplying pulleys, controlling valve, and automatic stop.]

sired power and travel of the elevator. In this cylinder there is a piston with rods attached, these rods passing out of the end of the cylinder through stuffing boxes. The ends of the rods are connected to a pulley or a series of pulleys around which the lifting ropes pass, these ropes being led upward to pulleys at the top of the building, and thence downward to the car. When the cylinder is placed in a vertical position, it is filled with water on both sides of the piston, the upper side of which is acted upon by the water pressure. Due to this power the piston descends through the length of the cylinder drawing in the rods, and therefore pulling upon the ropes, which in turn raise the car.

On the principle of the block and tackle, according to the number of pulleys attached to the piston-rods and working in connection with other pulleys in line with the movement of these rods, the movement of the piston through one foot of space actuates the movement of the car through one, two, three, or more feet of space.

The car having arrived at the top of the shaft, and the water below the piston having been forced out, the operating valve is reversed. No longer is the pressure permitted to act upon the piston, but the weight of the car or descending load tends to make the piston travel back to its original position, and in so doing the water is forced out of the top of the cylinder into the lower end, filling the space previously occupied by the former discharge. Thus the elevator in its descent performs its own work through gravity, and simply circulates the water from the top of the piston to the bottom of same, perfect control of the descending load being possible by the government of the


HYDRAULIC PASSENGER ELEVATOR WITH VERTICAL CYLINDER.



SECTION OF VERTICAL HYDRAULIC ELEVATOR CYLINDER.

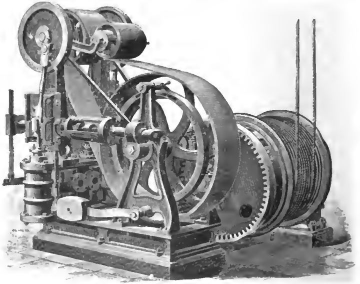
rapidity of this circulation. When the cylinder is placed horizontally, one end is usually open to the air, and the travel of the car is regulated by the rapidity of influx of the water to or outflow from the pressure side of the piston. The reader can readily imagine how many devices are possible, all of which would incorporate the principles of operation, as described.

The vertical cylinder was the invention of Mr. Cyrus W. Baldwin, and the elevator first constructed under his patent was known as the Hale elevator. Subsequently, and for many years, the right to use this system was owned by Otis Brothers & Co., but at the present time effective patents cover minor details only.

The practical use of electricity has become so extensive of late years, nearly all towns of any magnitude being provided with installations for both lighting and power with supply mains distributed over large districts, that inventors have turned their attention to the application of electricity to elevators.

Many electric elevators are now in successful operation, and, though it is not probable that electric power will be generated in a building especially to propel the elevators, at the same time where, by simply tapping electric mains in the street, power may be obtained, the electric elevator is destined to come into very general use. It is true that up to the present time no such elevators have been produced equaling in capacity, speed, and control the great hydraulic elevator systems in use in the large office structures of New York and Chicago, but from the progress already made it is possible that electric elevators will in the near future rival these splendid examples.

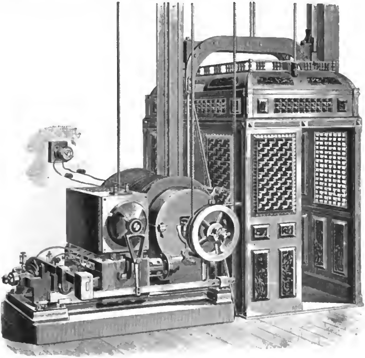
Naturally the designers of electric elevators followed closely the lines of construction already developed in steam and hydraulic elevators, and as a consequence two general types exist. The first, and the one by far the most generally used, is similar to the steam passenger elevator, in which the cables are wound on a drum revolved by a worm and gear, the worm being revolved by an electric motor, the motor thus simply taking the place of the steam-engine.



STEAM ELEVATOR ENGINE AND WINDING DRUM.

In the second type the principle of the tackle, so generally applied to hydraulic elevators, is used, the fixed and traveling pulleys being made to approach or separate by a long screw carrying a nut to which the traveling pulleys are attached, the long screw being revolved by an electric motor. This latter type is somewhat experimental, there being at present but few examples in practical operation.

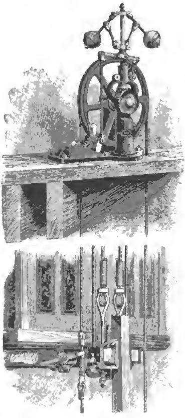
An elevator-car bears about the same relation to the motive machine, which is the soul of the elevator, that a railway car bears to the locomotive that draws it. The traveling public see the locomotive, but few question or investigate, and of the millions carried in elevator cars daily how few have ever seen the propelling machine, or given a thought to its principles and construction.



AN ELECTRIC ELEVATOR.

Travel in elevators seemed dangerous at first, and naturally so, since the disastrous result of a car falling was clearly apparent. But in fact serious accidents are so carefully guarded against by good construction and efficient safety devices that fewer persons are injured in elevators than in any other mode of travel, and a majority of the few who are killed or injured meet accident by falling down the shaft through doors carelessly left open or in attempting to enter or leave the car while it is in motion,—mishaps not directly attributable to the elevator.

The accidents to which elevators would naturally be subjected and to prevent which safety devices are provided are: falling, through breakage of the ropes or other parts of the apparatus, overrunning the proper travel either at top or bottom, or loss of control by the attendant. Falling of an elevator-car is a rare and almost unknown accident, and, though frequently we read in the newspapers of falling elevator-cars, such accidents usually prove to be on investigation simply cases of loss of control, or, in other words, "runaways."



SAFETY GOVERNOR.
[Showing attachment to wedge safety-device under bottom of car.]

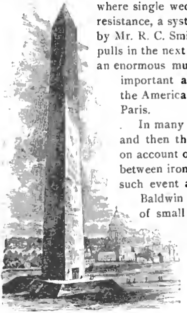
The makers of the better class of elevators allow a large margin of strength, and duplicate the parts liable to breakage. They use at least two, and generally four, and often six or eight cables, any one of which is capable of supporting the whole load, and some makers so arrange the cables that the breakage, or even abnormal stretching, of one or two of them will operate the safety devices and so prevent the use of the elevator until the defect has been remedied.

Under such conditions it is readily seen that the fall of an elevator car, through breakage of the cables, is almost an impossibility; in fact, the writer has never known a case of a first-class modern passenger elevator falling from this cause. Notwithstanding these precautions in construction, devices are attached to automatically stop and hold the car in the event of a complete breakdown.

One of the oldest, simplest, and best-known safety devices consisted of toothed racks, usually of cast-iron, running the whole height of the shaft, into which strong steel bolts, called dogs, were shot by springs automatically liberated on the car when the cables should break, the springs being held in compression by the tension of the ropes. These "safeties," while very efficient, and answering well at slow speeds, produced too great a shock when operated at high speeds, and hence, as high speeds became a necessity, they were abandoned for safeties producing a more gradual stop.

To-day the device in most general use consists of wedges which, when automatically liberated, compress the vertical guide-strips, usually of hard wood, on which the car runs, until sufficient friction is produced to stop and hold the car and load. In some cases, where single wedges will not produce sufficient resistance, a system or train of wedges invented by Mr. R. C. Smith is used, in which one wedge pulls in the next succeeding one, thus producing an enormous multiplication of power. The most important application of this safety was on the American elevator at the Eiffel Tower in Paris.

In many cases iron guide-rails are used, and then the simple wedge is impracticable on account of the low coefficient of friction between iron and iron when lubricated. In such event a safety designed by Mr. C. W. Baldwin is generally adopted, consisting of small hard steel rollers with file teeth, which, when in operation, are automatically jammed against the iron guiding surface. To guard against disaster through loss of control or runaways, caused by derangement of the machinery or carelessness, a speed governor similar to those used on steam-engines is em-



WASHINGTON MONUMENT.

Contains a steam passenger elevator having a vertical travel of 500 feet—the highest rise of any passenger elevator in the world.

ployed to liberate the safeties and throw them into action when from any cause the car attains in descending an undue speed. Sometimes the governor is placed at the top of the shaft and connects with the safeties by a wire rope, which serves also to transmit the motion of the car to the gyrating balls, and sometimes it is placed on the car itself; in either case its functions are the same.

To prevent overrunning, special mechanism is used, which consists simply of automatic devices for shutting off the steam, water, or electricity, when the elevator reaches the end of its run, and, in the case of steam or electric machines provided with friction brakes, these devices cause the brakes to be automatically applied.

The hydraulic machine is intrinsically safer against overrunning than any other type, for, when the piston reaches the end of the stroke and butts against the end of the cylinder further motion of the car must necessarily cease.

Elevators, like all other machines, however safe they may be when new, can only remain safe when properly cared for and kept in order. So many cases were found where no care was given by those placed in charge by owners, other than such as was absolutely necessary to keep the car running, that Otis Brothers & Co. about eight years ago organized a bureau of inspection, which for a small annual sum periodically examined and reported to the owner the actual condition of the elevator, with recommendations as to what was required for safety. The success of this system was so marked that all the principal elevator-builders rapidly followed suit, and established similar inspection bureaus.

The various accident insurance companies soon saw the opportunities offered by this field, and now these companies, for an annual premium, not only regularly inspect elevators, but also insure their owners against damage for accidents, and defend any suits for damages which may be brought against the insured. It is needless to say that the recommendations of the inspectors for the insurance companies receive prompt attention, as otherwise the policies would become void.

With how much more confidence the elevator passenger rides when he sees posted in a conspicuous place in the car the legend: "This elevator is insured and regularly inspected by the Blank Insurance Co." Were such a legend absent he might even reluctantly mount the staircase, which still is to be found in most office buildings, though rarely if ever used.

PROGRESS IN STEAM-ENGINEERING.

By Robert H. Thurston, LL. D.,

Director of Sibley College, Cornell University.

II.—PROBABLE FUTURE DEVELOPMENT.

As we have seen in the preceding paper, the improvement of the steam-engine has been effected by the gradual improvement of the machine in its thermodynamic character, as an ideal heat-engine, and the simultaneous reduction of those wastes which are characteristic of the real engine and which represent those imperfections of material and of construction which it is hoped that new inventions and new methods of operation will make, ultimately, comparatively unimportant ; reducing the real and the ideal machines to substantial identity. Hitherto this movement has been made, both as respects the improvement of the working conditions of the "working fluid" and the improvement of the machine in which it does its work, without change in the nature of that fluid, or the substitution of other substances for steam ; which substance has hitherto done substantially all of the work of the world, so far as performed by heat-engines. Whether combustible gases, the liquid fuels, or other substances will ever, in the course of this improvement of the working fluid, replace steam, is uncertain ; but some recent authorities are inclined to expect this finally. There seems no reason to suppose, however, that superheated steam may not, in the end, do all that is expected to be done by the highly-heated products of combustion of such other fuels acting as working substances. For the time, at least, we see no other way of improving our utilization of heat-energy than by the two main processes of further refinement of the steam-engine described in the previous article,—increasing thermodynamic efficiency of the ideal engine and decreasing the extra-thermodynamic wastes of the real machine.

The reduction of the various wastes of the engine—both ideal and real—has been effected by the enhanced thermodynamic action, which leaves a smaller proportion of the heat supplied to be rejected as the so-called—and to some extent inevitable—thermodynamic wastes ; by the more careful covering of the heated parts of the machine to prevent heat from escaping by conduction and radiation to surrounding objects; by reduction of dynamic losses through friction; and especially by the various expedients which conspire to lessen that most remarkable of all these wastes, the internal losses by conduction to and from the metallic walls of the cylinder, resulting in what is technically termed "cylinder condensation," "extra-thermodynamic condensation," due to "non-adiabatic expansion." In the old engines of Savery, two hundred years ago, the steam entering the machine was mainly condensed by contact with the wet and cold interior of the "forcing vessel," and by contact with the mass of water which it was compelled to force out by direct pressure; the consequence being that where one pound of steam was employed for useful work, about thirty were wasted by this "cylinder-condensation," as it has come to be called, in even the best of these machines.*

The modern type of engine, as first used by patrons of Newcomen, a little later than the time of Savery, utilized about one pound where it wasted by condensation in its working cylinder nearly twenty pounds of steam, by the same process of heat-absorption by the metal of the cylinder, and by the cold water besprinkling its surfaces; notwithstanding the enormous gain effected by the separation of steam cylinder and pump, an improvement even more striking than that made by Watt in separating the cylinder and the condenser. James Watt reduced this waste about one-half by his earlier improvements, and to about seven or eight to one before his death. In the latest forms of engine, by the use of better methods of drying steam, by more rapid motion of the engine, giving less time for this waste, and especially by compounding the engine, in such manner that the wastes of one cylinder are comparatively small, and are nearly identical in amount and in effect in reduction of the same charge of steam in each, one cylinder practically measuring the waste of the combination, this loss has now come to be small; and in the best engines may be as little as 20 or 25 per cent. of the total quantity of steam supplied. Taking pumping-engines as the best gage of progress, the improvement of the machine to date may be fairly taken as below:†

"DUTY" OF STEAM-ENGINES.

A. D. 1700, Savery	5 millions.
A. D. 1770, Newcomen	12 millions.

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* "History of the Steam Engine," p. 45.

† "Manual of the Steam-Engine," Vol. I., p. 32.

A. D. 1780, Watt	27 millions.
A. D. 1830, Cornish	87 millions.
A. D. 1890, Multiple-cylinder	120 millions.

This "duty," as here taken, measures the useful work, in foot-pounds, performed by 100 pounds of fuel. Were there absolutely no engine-wastes, the figure would become about 200 millions, the loss being, still from this internal thermal waste, mainly, about forty per cent. in the better class of modern engines; although one or two cases are now reported in which the wastes are reduced to below thirty per cent., external and internal. Dividing 200,000,000 by the "duty" will give, roughly, the consumption of fuel in pounds per horse-power per hour; and it is seen that the gain since the days of Newcomen and of Watt has been the difference between about 16 pounds and 1⅔ pounds. The best modern figures are not absolutely established, but are probably not far from 1¼ pounds,—certainly not above 1½ pounds. Newcomen and Watt worked with steam at about atmospheric pressure, in single cylinders; while modern engineers, making such records as the last, employ several atmospheres of pressure with multiple-cylinder engines, usually "triple-expansion," with careful provision for, as Watt said, "keeping the cylinder as hot as the steam entering it," and, at the same time, making that steam so dry, the engine-speed so high, and the action of the jacket so effective, that substantially all steam received into the engine does some, if not its full, share of the work.

Increased speed of piston and of rotation is easily seen to be an element of this gain. Watt adopted a speed of piston of 128 times the cube root of length of stroke, or from 128 feet, 64 revolutions, in a small engine of one-foot stroke of piston, to 256 feet, 16 revolutions a minute, in engines of large size and of eight-feet stroke. To-day, the so-called "high-speed engine" for electric lighting purposes, and the locomotive hauling fast passenger trains, and the more recent and powerful of marine engines, all come up to at least 600 times the cube root of stroke, and make from 300 revolutions in the small sizes down to nearly 100, with marine engines of five- and six-feet stroke, and of 10,000 horse-power and upward.

Thus, while the refinements introduced by inventors, from Newcomen and Watt to Sickles, Corliss, and Green, have reduced the *thermodynamic* demand of the engine, exclusive of wastes of other kinds, from a theoretical fifty pounds of steam per horse-power per hour to about eight, or of fuel from about four pounds to about three-quarters of a pound, they have also reduced the thermal wastes of the engine from something like ten times these figures to hardly more than an added fifty per cent. But 50 per cent., still to be gained, represents an enormous value when computed on 50,000,000 of horse-power; and the average engine offers opportunity to double and treble this profit by reduction of these wastes to insignificance. It may be probably safely estimated that the wastes of the steam power of the world, through the operation of causes more or less capable of amelioration by the ingenuity of man, would still amount to pretty nearly 300 million tons of coal every year, assuming all this immense power to be in constant operation ten hours a day. This is more than the total production of coal in the world at present, probably, but not more than will be necessary, if this waste is not checked at a very early date. Probably the steam-engines of the world, as an average, are not in operation half the time assumed, and, in a large proportion of cases, not even then at full power. The locomotive works, as a rule, but a few hours each day; the marine engine works a few days continuously and then stops for days or weeks; and even the regular operation of the engine of the cotton-mill and of the workshop is interrupted one day each week, and sometimes for days together, for repairs; so that both consumption and wastes of fuel are much less throughout the world than would be indicated by the statistics of steam-power. Perhaps one-fourth the above figure might be taken as fairly representative of the opportunity for gain remaining in visible directions.

The friction of the engine has never yet been given that attention which it demands as an element in the improvement of the economy of the machine. Amounting, as it still does, usually to 5 per cent. in non-condensing, and to 10 per cent. in condensing engines, as compared with the whole indicated power, it is a very heavy tax on the machine and its proprietor. So far as can be now seen, the only ways to reduce this from the actual to the possible, from the above proportion to perhaps a small fraction of those figures, are to make the contact of rubbing parts as light as possible, their movement as small as practicable, and the friction-coefficient as minute as possible; in other words, to make the now large and excessive work of friction the lowest quantity yet known in the best practice, in every direction. Piston and stuffing-box friction, now usually large, can be reduced by making such constructions as will insure steam-tight fits without pressure, as is approximately done, in a few instances, by metallic packings for the latter, and by special constructions of ring for the former; valve-friction is reduced to insignificance by balancing; and the other large item, journal friction, may be made a fraction of its customary amount by flooding the bearings with oil, making suitable provision for its continuous circulation, with thorough filtering. It would seem remarkable if this waste of 10 per cent. or more of the expense of operation of steam engines could not be reduced to one-half or even to one-fourth its present amount by the intelligent application of well-known facts and principles.[*] If, by the progress of improvements, thus seen to have been inaugurated by Newcomen and Watt, one and two centuries ago, the recognized extra-thermodynamic wastes of the steam-engine may be made unimportant, we may hope to see the time when about ten pounds of steam and one pound of good fuel will be looked upon as the goal to be fairly, reasonably, and confidently aimed at by the designer and the builder of the steam-engine of the early future.

For some purposes, as in naval engineering, whether for the navy or the merchant marine, concentration and lightness of machinery are no less important than economy in operation; while for aeronautical applications, now coming to have recognized importance in military operations and possibly for limited use in civil life, this is the prime essential. Progress in this direction is best gaged by the weight of the machine, which has been brought down from about one ton in the earlier part, to 500 or 600 pounds per horse-power in the middle of the century, and to 200 pounds and less in contemporary marine practice; while, in special cases, as in torpedo-boats and fast yachts, the figure has been reduced to less than 100, and even in a few instances to not far from fifty. Mr. Maxim has succeeded, by the use of tool-steel and specially arranged parts, and by the application of extraordinary ingenuity, in making an engine costing a dollar per ounce or more, but only weighing about six pounds per horse-power, as estimated. Even better work is said to have been done by Langley, and still lower figures are promised by other ingenious mechanics. The best work reported to date in aerial navigation has been that of French experimenters, who have driven their spindle-shaped balloons at the speed of a slow railway train by the use of electrical energy from storage batteries; but the "aviators," as the believers in the more familiar methods of the birds are called, insist that they will yet make steam do this work far more satisfactorily, and make a speed of fifty miles an hour their lowest limit. The discoveries of the astronomer Langley, showing that it is probable that a high speed will be found at which it will be easier to propel the machine than at any other, either higher or lower, lends confidence to the never-discouraged inventor. On the other hand, the believers in the employment of electric energy, as the means of most effective concentration of powers, are proposing to extend their conquests even to the capture of the transcontinental lines of railway, and expect to connect the great cities by lines of rail, on which they will drive their projectile-like trains at a speed of one hundred miles an hour and upward. That this is practicable as a mere matter of engineering and construction seems probable enough; that it will prove commercially practicable is the really doubtful question. In any case, steam stands behind the scenes and must serve as the prime motor for the whole system, and electricity takes its part by introducing an extensible arm between the mist giant and his work. The giant himself is, at least at present, too ponderous to be profitably carried as a passenger on his own trains.

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[*] "Manual of the Steam-Engine," Chapter V., articles 132-136; "Friction and Lost Work in Machinery and Millwork," Chapter VII., articles 143-145.

The problems remaining to be solved are such as these: securing fuel of minimum volume and weight with maximum heat-producing power; making boilers safe for still higher pressures; extending still more widely the range of thermodynamic transformation of the thermal into dynamic energy; reducing still further, and greatly, the wastes of the engine, especially its internal heat-wastes; and concentrating the mighty power of steam into even less compass and weight. Liquid fuels give about twice as much power as the coals, per pound and per cubic foot; boilers composed of many small chambers give greater safety, both from explosion and in case of explosion at high pressure; increased pressures, with further multiplication of engine-cylinders, promise further economy, and superheating the steam, should this ever be found permanently and safely practicable, gives perhaps even greater promise in this direction; the better kinds of iron and especially of construction-steels, the new alloys constantly coming into sight, and the more skilful use of materials by the designer, are conspiring to give further concentration of power, both in weight and space; and there seems to be no reason to doubt that the immediate future holds out promise of continued, perhaps of still accelerated, advances in all these directions, and of as many astonishing changes in the coming generation as have distinguished that just passed.

For the moment, at least, the advances of the century have brought us to the construction of steam-engines light enough to compete successfully with the motive organs of the birds; others economical enough to give us a horse-power for an hour with every twenty ounces of fuel burned in their boilers, and to carry a ton a mile, at sea, on the expenditure of a half ounce of coal; quick enough in their rotation to accompany the spinning armature of the dynamo-electric machine and to drive their dispersing energy over miles of wire, to give light or power to distant buildings or to cars loaded with a hundred passengers. The culmination of human ingenuity and skill seems to be presented in the new ocean steamers, weighing ten to twelve thousand tons, driven across the seas at the speed of twenty-five or more miles an hour, by the power of 20,000 to 30,000 horse-power; converting into that power the latent energies of the comparatively small quantity of coal that can be carried in their holds, beside their immense loads of cargo, and while transporting a thousand passengers with their almost as numerous attendants.

Should this progress culminate in the discovery of methods of direct conversion of the energy of chemical forces into mechanical power without those enormous thermodynamic losses now apparently absolutely inevitable between our coal beds and our various machinery, our own times will very probably stand to those of future ages as, in respect to intellectual development, the days of the ancient Greeks stand to later times.

FIRE RISKS IN ELECTRIC INSULATION.

By Frederic A. C. Perrine, D. Sc.

IN the early days of electric-lighting—and not more than ten years ago at that—the writer was sent, together with other workmen, into the cellar of the laboratory connected with a prominent electric-lighting company, with instruction to run the various circuits which were to be used in carrying current to the switch-boards and instruments placed in the room overhead. We were furnished with a beautiful copper wire covered by a braiding of cotton yarns saturated with white paint and polished until it shone, a plentiful supply of staples, and such hammers as the stock-room could afford. In stapling the wire to the floor-beams over our heads, we were far enough advanced in electrical knowledge not to drive staples through the covering to the copper intentionally, and were well enough skilled in the use of the hammer to avoid striking the wire and knocking off the insulation in very many cases; though when lying on one's back and pounding in the dark with eyes filled by dust and dirt it was not strange that a misdirected blow would occasionally fall.

Is there any wonder that when a year had passed and I was working as an electrician,—having been promoted from cellar to laboratory—annoying fires would often occur and interfere with the experiments, bringing the necessity of pulling the switches and making the wires "dead" till the defective insulation of the circuits could be repaired? To be sure, these fires would occur most readily where holes in the floor allowed water from the morning mopping to trickle through to the beams below, but it is hardly possible that such construction would be attempted to-day even in the dryest garret.

Installations such as this, often followed by disastrous results, occasioned the fear of fires from the use of the electric current in the early days of electric lighting, and those early days, being so little removed from these present days, remain in men's minds, making them ask, "Can electricity be safely installed?"

Electricity, it must be borne in mind, is always and everywhere convertible into heat by passing it along a medium offering resistance to its progress, while the amount of heat developed is directly conditioned by the amount of current to be passed and the measure of the resistance to be overcome. The smallest current of electricity passing over the best conducting wire to be obtained raises the temperature, be that rise ever so negligable, but it is very far from being true that this amount of increase of temperature may not be perfectly controlled in circuits which are carrying their normal currents under no accidental circumstances.

The fires which may be occasioned by the introduction of electricity into our homes and workshops may be roughly divided into two general classes,—those arising from an undue amount of current overheating the wires themselves, and those due to current escaping through defective insulation. Consequently the greatest care must be used in laying out a wiring system to avoid either of these causes for trouble.

To recur again to the early days, which even young men may remember, the defective construction above referred to was at fault only in the latter point; the copper wires were of ample area to carry any current likely to be sent over them and the covering used was one as nearly fireproof as any ever devised, so that had even a considerable amount of overheating occurred there would have been little danger that the high temperature of the circuits would set fire to the building, but it was not realized that currents might escape from the wires and, running along the damp beams, set them on fire through the current which the wood itself was carrying. Indeed, the object-lesson of a tree burning on a wet night set on fire by some escaping current from an electric light wire is even at the present time not altogether unknown.

Very early in the history of the art it was wisely recognized by the insurance companies that a properly installed system of electric lighting might be made at least as safe as gas or any other means of illumination, and in order to guard their interests strict rules have been laid down and inspection of all installations enforced by their agents. On account of this fact there have been a corps of men in their employ engaged in ascertaining all the possible causes for such fires and from their experience formulating the requirements of perfectly safe installations.

In laying out his circuits the electrician's first concern is for the loss of energy occasioned by forcing the current over a wire, and at the same time he endeavors to have the outlay for copper and insulation as small as possible. With any definite percentage of loss it may be possible that the wire employed will be of such a size as to produce dangerous heating, and to guard against such an effect the rough rule was at first laid down that the density of the current should not be more than 1000 amperes per square inch of cross section of the wire. This rough rule took into account only the heat generated and did not allow for the fact that, while the heat was generated throughout the entire mass of the wire, it was radiated only from the surface, which in any round wire varies as the diameter while the cross section or mass varies as the square of the same dimension.

For comparatively small wires this rule is sufficiently accurate, but through the experimental investigations of Kennely and Forbes there have been deduced formulæ by the means of which wires used under all conditions may be accurately proportioned for any definite increase of temperature, and at present the wiring rules state either the amount of current which each size of wire may safely carry under certain conditions or that the rise in a circuit shall not be beyond a certain amount above the temperature of the surrounding air.

In such perfectly proportioned circuits local increases of temperature to a dangerous amount may be occasioned by the extra resistance of a defective joint between two pieces of wire, and such a contingency can only be guarded against by careful workmanship in soldering all joints which have at first been well secured by twisting or by the means of suitable sleeves and couplings.

In spite of the best designed and best constructed system of wiring, accidental crosses may be occasioned by decay in the insulation or by mechanical occurrences which bring the two wires of the circuit into contact, cutting out the lamps or motors beyond the point in question and throwing the whole power of the machine into a much diminished resistance; a great rush of current follows, and high heating is produced. Similar effects may be produced by crosses with the wires from another system in which the pressure is greater than that for which the wiring has been calculated.

Now, to guard against the evil effect of any such great accidental increase of current it is found advisable to sacrifice some one portion of the circuit in question and avoid the overheating of wires in the neighborhood of inflammable materials. For this purpose, at all the branches in any circuit, as well as at the point where the main wires enter the building or leave the dynamo, small porcelain boxes are placed containing terminal contacts for the wires and making a break in the circuits which enter and leave them ; in this gap between the contacts safety-fuses are introduced into the circuit. These safety-fuses are short pieces of wire made from some fusible alloy capable of melting at a temperature too low to set fire to any inflammable material on which it may fall while melted. Each fuse for any circuit is so proportioned that a definite amount of current will melt it, and in this manner a dangerous increase of current will automatically break the circuit and stop its flow.

Indeed, these little safety-fuses are the most important element for protection against fire in any electric installation, and the greatest care must be used in their location and proper maintenance. Provided the wireman in his haste has not substituted for them bits of copper or handy nails, the installation which is properly "fused" may be considered safe.

Any cause whatever of an increase of current above the normal will make these ever watchful little safeguards surrender their lives to the good of the remainder of the circuit. To be sure they are but mortal and have their almost human failings, and they may persistently burn out if placed in an overheated room ; they may not be quick enough to prevent some "sneak" current which follows a minute break in the insulation from setting fire to a board along which it finds its way to a neighboring gas-pipe, but in the main they are true monitors and their warning should be heeded.

The "leaks," "crosses," and "sneak currents" spoken of above are all fertile causes of electrical fires, and are occasioned by defects in the insulation of the wires which result in currents passing over resistances so great as to cause undue heating. Either by the "crosses" sending too great currents over wires properly proportioned for their normal work or by the "leaks" sending currents of electricity over semi-conductives, such as damp woodwork, while the "sneak currents" are minute leaks which do not send a sufficiently great amount of current astray to increase the amount in the circuit sufficiently for blowing out safety fuses.

While the safety fuses are the reliance when these accidents occur, yet in the normal and possible circuit the fuses are never called upon to perform their office. Insulation is the means of prevention of all these dangers ; insulation is the great need in a safe installation ; to the insulation we must look in installing our plant, and to the maintenance of the insulation we should devote our energies after the circuit is in operation.

As modern plumbing, gas fitting, and steam piping have revolted against concealed work, so the first method which has been successfully adopted for safely running wires in buildings and the method which is always used in factories is to run the wires in plain sight, and when porcelain or other non-absorbent insulators are used in supporting the wires to keep them away from contact with the surrounding woodwork or walls a very high degree of safety is obtained. There is the single objection to this method of construction in the power the electrified wires have of attracting and retaining floating particles of dust or lint, such as are often continually flying in the air of a manufacturing establishment. I have seen wires in such a place, which originally were hardly more than a quarter of an inch in diameter, attract cotton lint till they were more than an inch across, having the appearance of some hairy caterpillar creeping along the beams of the floor above, and I have known such dust-laden wires to carry a small fire in all directions till, before the original blaze could be extinguished, a half dozen other fires had been kindled and the building was doomed to destruction. Of course such an effect is only indirectly due to the electric installation, but, had the danger been appreciated and the wires kept free from such attracted particles, the small amount of labor necessary for the task would have saved thousands of dollars.

In an office building or a house, however, these unmasked wires interfere too much with the surrounding decorations or wall finishings, for, wherever the circuit is run, lights are needed in many places in the room, and the network necessary on the ceiling is apt to be very unsightly, especially as it seems impossible to run and keep the wires straight in all changes of temperature unless they are supported through their entire length, so that the expense of endeavoring to produce a decorative piece of work in such a manner amounts to as much as that necessary to do concealed work safely.

For concealed construction the first method used was to incase in a lead pipe the wire which had been previously carefully insulated with rubber on a saturated fiber; such a lead covered cable was then buried in the plaster of the walls or placed behind the lathing with the ends brought out to the various switches and lights. Though thus to cover the wire with a double waterproof protection of an insulating material and an impervious lead pipe may seem at the first sight an ideal method of installation and one likely to be enduring in its properties, yet I have seen short circuits cause the plaster to fly in all directions from the walls of one of the handsomest public buildings in the country when the current was first turned on the circuit; and though the electric plant had cost thousands of dollars, it was soon almost beyond repair, and in the place of these buried lead cables it became necessary to use a most unhandsome external circuit in preference to tearing out and replacing the defective wires; which alternative would have necessitated replastering a large portion of the building. And yet this trouble was not due to any defect in the method or the original properties of the lead cables, but to the impossibility of obtaining perfect workmanship and absolute care on the part of all the men, carpenters, lathers, plasterers, and electricians, who had been engaged upon the immense building.

At the present time the likelihood of defective workmanship and mistakes is recognized much more fully, and it is not attempted to build an inflexible system into the walls of any building, but methods have been devised by which it is possible to withdraw defective wires and replace them without injury to the walls or woodwork of the building. Of course something must be fixed in the installation, but it is preferred at the present time to fix the conduit conveying the wires rather than the wires themselves or their insulation.

In old buildings where gas has already been installed and it is not deemed advisable to tear out the walls for a system of conduits there has been devised a neat molding having two grooves into which the wires may be laid, where they are then covered by a cap running lengthwise of the molding, and which, when completed, may be painted or made to harmonize in any other manner with the neighboring decorations.

While this molding system of conduits is extensively employed in old buildings and along wooden walls such as are found in our magnificent river and sound steamers, it is generally regarded with less favor than a system of round tubes made of some insulating material which are run under the plaster and terminate in junction boxes from which the wires may be pulled through the tubes. This is perhaps the safest and most satisfactory system for wiring any building, and this method combines the least possible interference with the decorations together with the greatest immunity from fear of fire. The tubes here spoken of are made in some cases of paper strips wrapped spirally around a mandrel, the tube so constructed being plunged into melted asphalt which is maintained at a high temperature; some are made of a low grade rubber, and others of a combination of a paper tube with a rubber sheath, and the whole finally finished by a braided covering. The two latter tubes, being flexible, do not require any elbow pieces at the bends and present a smoother internal surface for drawing in the wires, but they possess the disadvantage that, on account of their flexibility, they are not so capable of resisting accidental blows or misdirected nails while the plant is being installed.

When such a complete system of tubing has been installed in a house and connected to the junction boxes, there is provided a continuous insulating and waterproof conduit passage for the wires from their original entrance into the house to the last light. The fuses, which must be as carefully attended to on this system as on any other, prevent any great rise in the temperature of the wires due to any external causes; while the tubes themselves offer no path for the leak through a defective insulation, and, in consequence, any system so installed may be considered to be perfectly safe against danger from a fire caused by the electric installation.

As we have said already, the fact that electricity is always convertible into heat by passing a current over a resistance, taken into account with the defective character of the early installations, has served to turn men's minds to electrical fire risks and made them inquire into the means of prevention of such fires; it is therefore useful to examine the statistics of our fire insurance companies and note what proportion of fires are of electrical origin.

From 1884 to 1889 the Massachusetts Insurance Commissioner's report shows that out of a total of 12,935 conflagrations in the State there have been 42 traced to electric wires,—scarcely half of one per cent. While it is yet more striking to notice that in 1887 there were 14 fires of an electrical origin, and in 1889 there were but 7 such fires in approximately the same total,—but one more than in 1884,—and this too in the face of most enormous extensions in electrical installations.

In this connection it is interesting to note the other causes which are comparable to electricity in producing fires, and one is astonished by their triviality.

Kerosene oil (breakage and explosion)	947
Careless use of matches	437
Curtains or goods exposed to gas or candle	224
Thawing water-pipes	89

Clothes drying near stove	64
Fat boiling over	43
Cigar-stub in wooden spittoon	41
Smoking in bed	34

And it is further noticeable that the most important of these causes are accompaniments of other methods of illumination.

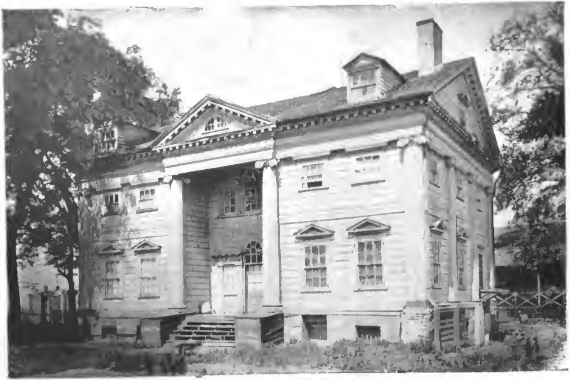
To be sure, it is true that even the most trivial cause may be the origin of the largest fire, as in the oft repeated story of the great Chicago fire, which was started in a stable by an overturned lantern, and as was recently the case when in Lynn, Mass., "a draft from an open door blowing the blaze of an oil stove down around the burner, causing the stove to explode," originated the great fire which consumed so many of the shoe factories of that city in 1889.

In his report for that year the Insurance Commissioner, after commenting on that Lynn fire, says: "In the case of Boston the preponderance of testimony seems in favor of the theory that it was caused by the electric wires; and, if this be the true theory, then it follows that two fires, which together destroyed over eight million dollars, could easily have been avoided."

Indicating therefore that in the judgment of this high insurance authority, Mr. George S. Merrill, a fire from an electric installation is practically always preventable if the work is properly done and the installation regularly tested. We believe that we may truly say therefore that an installation for the electric lighting of any building may be made perfectly safe as regards fire risks; using the word "perfectly" in the human sense, for we know nothing connected with either science or our daily lives in which every form of possible accident may be absolutely guarded against.

Such a perfect installation we now understand to be one in which the wires have been properly proportioned to carry their normal current without undue heating; where also fuses are placed on all the branches to blow out whenever the current rises dangerously above that normal; and where not only the insulation of the wire is thoroughly waterproof, but where also its supports are of an incombustible waterproof character and so arranged as to keep the wire out of contact with all combustible materials; and, above all, where by proper inspection, cleaning, and testing, the installation is maintained in its original character throughout its entire life.

To be safe, then, good and honest workmanship must be maintained by constant watchfulness and not by fancied security.



OLD COLONIAL STYLE MANSION-HOUSE.

[Washington's Headquarters. Ninth avenue and Ninety-first street, New York city.]

MODERN AMERICAN COUNTRY HOUSES.

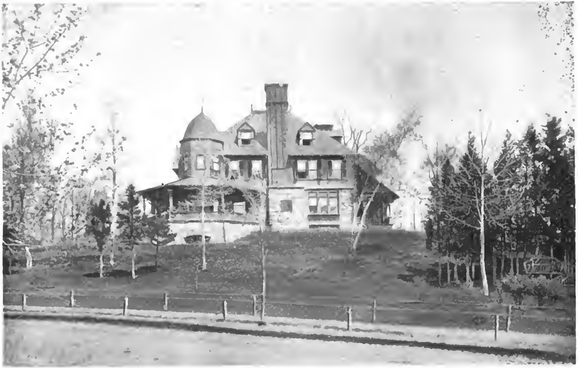
By John Beverley Robinson.

LET us take up the designing of a country house as an architect takes it up in each individual instance. First, as to arrangement : and, before we can do very much definitely with that, we must have some notion of the general appearance of the house as we wish it to be ; whether a blocky mass, after the fashion of the quasi-classical house of a century ago, such as the old house until recently existing in the upper part of New York City, or whether a thing of points and gables tossed together skilfully and artistically, such as the more modern house at Short Hills, of neither of which examples do I know the name of the designer ; whether low and rambling, or piling up pyramidally. No matter which the surroundings and circumstances may lead us to select, we can make a good thing of it as a design outwardly if we are clever enough.

Having made sure of what we want as to general effect, and, if we know what we are about, having been influenced in the choice by no considerations of fashion or imitation, but solely by the consideration of what will best suit our location, we try what sort of an interior we can devise that will work with such an exterior as we are aiming at.

We would like perhaps a square entrance hall, with no vestibule, a large dining-room, and a larger drawing-room,—as it is now the fashion to call it, reviving the name by which it was known to me in boyhood. Besides we want a library, to be used also as a smoking-room, a sitting-room,—or morning-room as it is called in England, although the functions are not quite the same, as the English morning-room is used for breakfast and luncheon, as well as for general use between meals. There will be bedrooms wanted, of course, as many as we can get, probably more than can be placed above the lower rooms in one story.

With all there will be a strict money limitation, so that it will be no wonder if we have to weigh each requirement, relinquishing some, modifying others, insisting upon a few in order to make the outside, the inside, and the appropriation harmoniously fit together.

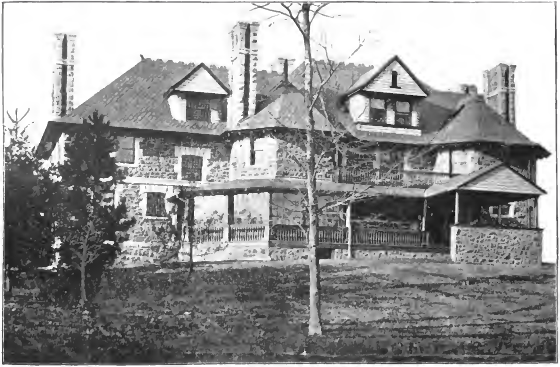


MODERN COUNTRY HOUSE AT SHORT HILLS, NEW JERSEY.

In arranging our rooms some of the English customs may be studied to advantage. In American homes the desire for wide sliding doors between the principal rooms is very general. The effect, when these doors are open, is spacious and pleasant, and the practical utility when the whole house is open for entertaining is evident. In England such wide doorways are unusual; each room is separate, giving a new scene and new interest as we pass from room to room. A typical American design is shown in the plan of a house at Englewood by Rossiter & Wright.

In our larger country houses there is a tendency to approach the English model in many respects, like causes as usual producing like effects. Such a tendency is shown in the plan of a country house in West Virginia by C. T. Mott. The reproduction does injustice to the magnitude of this house, the great hall being about sixty feet long and the dining room about forty. The development of a class of people of independent means and not depending on their labor for their living is producing very much such a house as the same class, long existing in England, has found best suited to its tastes there. The most marked feature is the double entrance,—the carriage-porch and the garden entrance, the one for the mere business of entering, the other the approach to the pleasure grounds, park, garden, or often merely what we would call a yard.

How spontaneously similar circumstances generate similar solutions is illustrated in the plan of a country house to be used as a shooting-box, designed by the writer. There was no especial attempt to imitate English methods. Given a large forest tract, where wild game abounded, a taste on the part of the owner for the chase, a house to be used chiefly for the gratification of this taste, the plan naturally follows. One story high, because there is no need of condensing into two or three. No cellar to speak of, because the coolness of the summer requires none for keeping things cool, and, the occupation being only in summer, no cellar is needed for heating apparatus, or as a frost-proof place of deposit. Immediately we have what is essentially the English country house. A large hall, paved upon the surface of the soil, properly prepared, in this case paved with brick; long rambling corridors, running off in one direction to bedrooms, in another to kitchens and the other offices, a dining-room, and a quite subordinate drawing-room, a boudoir for the ladies' use, a cosier refuge than the great hall. Finally come the stables and kennels enclosing the graveled quadrangle.



HOUSE AT ENGLEWOOD, NEW JERSEY.

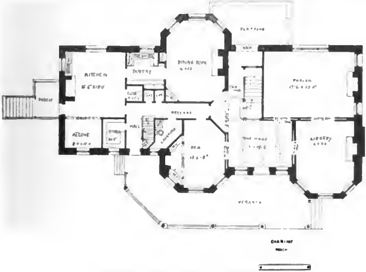
[Rossiter & Wright, Architects.]

The Hempstead house, by the writer, gives the double entrance again, the garden front—always the principal part—upon the lawn, the real entrance with covered carriage-porch in the rear.

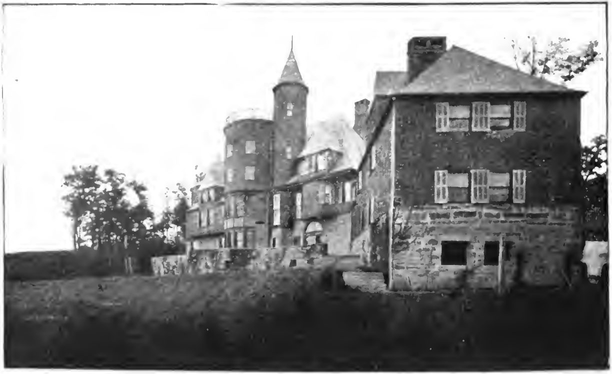
Some English arrangements will not bear copying,—their manner of separating the dining-room from the serving-room and kitchen, for instance. In a way that is manifestly studied, but for what real reason the American mind finds it hard to guess, their dining-rooms are placed so that all the dishes must be carried across the main hall, through the only door which is provided for entrance. Inquiry has disclosed that a dining room with more than one doorway is looked upon as "a terrible place for draughts," and in a country where unwarmed halls and bare neck and arms for dinner are the custom such considerations are necessarily paramount.

When we come to actually carrying out whatever plan we finally work out, the expediencies to be weighed and questions to be settled are innumerable. For most of them no perfect solution can be found; it is, at the best, accepting the inevitably imperfect. In every case, too, we must aim at the reasonably practicable financially; the very best way is often too costly to be prudent, even if there is money at hand to pay for it.

For the material of the outside, stone is rarely available. Rough



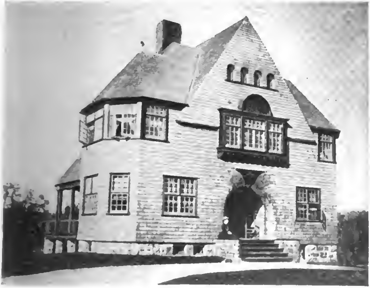
FIRST STORY PLAN OF HOUSE AT ENGLEWOOD.



COUNTRY HOUSE IN WEST VIRGINIA.
[Charles T. Mott, Architect.]

field stone when found on the spot may do well enough, but even then it is far more costly than the framed construction. The latter is the usual resort, covered with shingles, or rough cast or clapboards, if we can condescend to such banality. There is nothing more generally available than shingles; cypress lasts longest and greys well with the weather. Although white pine gives a whiter and more silvery grey, it is not so enduring. Cedar shingles turn blackish rather than grey, and are better stained.

Cement, plain or covered with pebbles, does well for parts or for the whole, and suggests masonry in a very satisfactory way. I have a notion that slate could be used more than it is for covering the sides of houses, as well as the roofs. The trouble is the objectionable color of the ordinary black slate,—the excessive uniformity of the market slate of all kinds. There is beautiful slate to be obtained which is regarded as waste by the quarries, very much as until recently the most beautiful brick were rejected by the kilns because they did not meet the demand for uniformity of color. These inferior qualities, as they are considered, I have reason to



HOUSE AT TUXEDO, NEW YORK.
[Bruce Price, Architect.]

believe are of as good quality as many others for wear. After a year or two they change color irregularly, fade into soft blue greens, olives, or browns, which make with the original green or purple a color effect which it is a joy to behold.

That people really do not care for perfectly uniform color is shown when the plaster walls of a church or hall are to be painted. The painter will mark them off into blocks and then carefully paint each block a slightly varying tint, and people will admire it accordingly. It is only the exaggerated and misplaced passion for neatness, which demands that grass shall be as green as possible,—as near in appearance to a painted board as it can be made,—that makes us forget our real inward appreciation of the beauty of surface color that is not uniform.

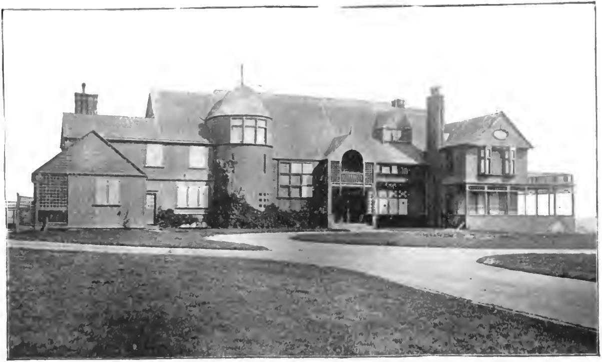
HOUSE AT LAWN RIDGE.
[Rossiter & Wright, Architects.]

They have a way in the West of veneering houses with brick, which is a perfectly legitimate and available resource. There they use it to imitate a brick construction, but such a fatal attempt at imitation is easily avoided. Properly used, a veneered brick house will have a character of its own and can be made no less satisfactory than shingles.

There is one point, trifling to the unprofessional mind but very important to the professional. I speak of what are called flashings. These are the metal sheets used for making tight joints in the angles of roofs, about chimneys, and in other places. Tin, however well painted, is sure eventually to rust into holes. Zinc is rustless and cheap, but apt to crack in putting on. Lead is good for many reasons, but best of all is copper. Use copper, if your purse can stand it, by all means, for flashings, gutter-linings, and all similar purposes. If not copper, lead and zinc judiciously used are always available,—zinc in small pieces, where much bending will not be needed; lead over doors and windows and built into chimneys for what are known as "cap-flashings." These make tight and permanent work.

HOUSE AT ORANGE, NEW JERSEY.
[W. C. Hazlett, Architect.]

In the interior the chief part of the work is plastering; the chief part, that is, in superficial measurement, as five sides out of six in each room are usually plastered. Of late years what are called hard plasters have been introduced. These are said to be substantially of the same nature as the well-known Keene's cement,—that is, of plaster of Paris mixed with alum and reburned. Asbestos fiber is mixed in to take the place of the usual hair. There are various makes of hard plaster, all of which are said to be good;

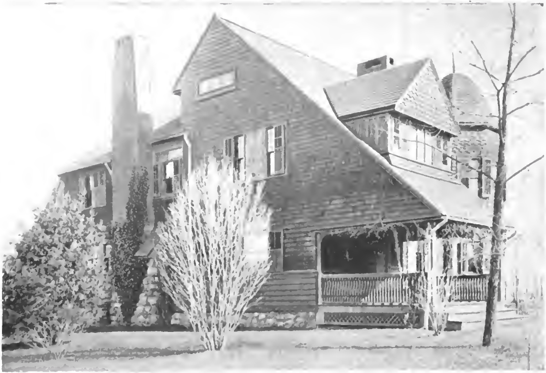


THE NEWCOMB HOUSE, ELBERON, NEW JERSEY.

the only one of which I can speak from experience is the "Windsor cement." Of this, one virtue I can distinctly affirm; and doubtless there are others which have the same advantage. It does not fall from the ceiling, no matter how much it may have been saturated. In other ways the hardness is of advantage, especially against the bruises and marrings caused by accidental knocks from furniture or otherwise. Hard plaster, however, has two drawbacks: the first is that workmen are apt to put it on as ordinary plaster is put on, which is sure to make it worthless; the other is that the harder and better it is the more it transmits sound through partitions and floors. With floors this is easily remedied by a layer of soft felt paper; in partitions no convenient and inexpensive remedy presents itself.

Floors come next to plastering, and are much more difficult to make satisfactory. Double floors of course we must have,—the under floor as rough as you like, only the boards must be of even thickness, and it is better to lay them diagonally than across the beams. Laid across, each wide board is sure, when it shrinks, to gather three or four of the narrower boards of the top floor together, making a wider crack than usual at that point. When they are laid diagonally, this difficulty is avoided. On this rough floor we will lay a thickness of deafening paper,—asbestos, if we can afford it. The real trouble comes with the top floor. No matter how much care is used in drying the material, cracks are almost sure to appear after a winter or two of furnace heat. The narrower the boards are, the narrower of course the cracks will be, and the more expensive the floor. In fact, if we must have the best floor possible, I should use the parquetry floor put down by experienced men who do nothing else. The cost would not be prohibitory, even for an ordinary fortune; not so very much in excess of a hard-wood floor in very narrow strips. It is possible that something in the way of a continuous paper floor may be seen in the future: the inherent defects of a wood mosaic are insuperable. Such a paper floor I fancy I could construct, but such new devices are not commercially available until somebody devotes himself to manufacturing them.

One word about windows. The usual guillotine sash, though the most convenient, is the ugliest thing possible. You may take your choice, beauty and draughts, or ugliness and what the yachtsmen call "weatherly qualities." On the other hand nothing can be prettier than the casement sash, opening outward, seen in the house



HOUSE AT SHORT HILLS, NEW JERSEY.

at Tuxedo, by Bruce Price. They are out of the way, too, of curtains and furniture, but, besides the other defects which almost all casements have,—of not being tight and of slamming and breaking the glass,—they have a curious and unforeseen drawback,—it is impossible to wash them on the outside without a ladder, or taking them off their hinges and lifting them bodily indoors. A pretty arrangement which avoids this inconvenience is sometimes available. The window is divided into four parts in width ; the middle pair of sash open outwards, the two sash at the sides open inwards, but are only intended to be opened for the purpose of washing the middle pair.

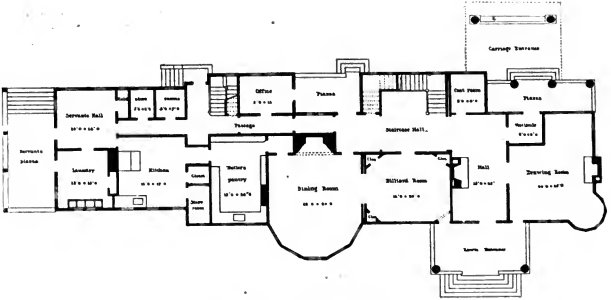
All the rest of the construction of the house—doors, stairs, closets, pantry arrangements, dumb-waiter, and such trifles no doubt they seem as door-knobs and sash-fastenings—I pass over, but to each the architect must give some consideration. Blinds deserve a moment, since they are the cause of much annoyance to both architect and owner. For the purposes for which blinds are devised nothing is equal to the ordinary outside blinds with movable slats. They exclude the sun and admit plenty of air ; even in a hard rain the sash may be left open inside of them,—an important matter in summer. Yet they have serious disadvantages. They detract from the appearance of every building upon which they are hung ; they slam and rattle in the wind and are awkward to reach in order to close them. In some situations, too, they are impossible,—upon a bay-window, for instance, where the space between the windows is not sufficient for the blind to fold back against, or in one of the pretty triplet or multiple windows, with mere mullions between, that so frequently adorn foreign work. In such cases we must resort to inside blinds of some kind ; the ordinary four-fold, with interstices too small to admit much air, and entirely unable to exclude rain ; the English Venetian, drawing up with cords, admitting air and rain too, and accumulating dust in an astonishing fashion ; or finally rolling or sliding blinds, costly and hard to find a place for,—how hard nobody knows who has not tried.

After the main part of the actual construction has been determined the no less important matter of appliances is to be thought out. By appliances I mean gas-fitting, plumbing, drainage, and heating. Sanitary plumbing has been pretty well exhausted as a topic, written and rewritten to revulsion. With drainage the case is much the same, but there is an interesting new development in this matter of drainage and sewage disposal which is beginning to be talked about and used, and will bear explanation.

Formerly there were but two methods generally available for disposing of sewage, where there was no sewerage system: by the ordinary cesspool, with various modifications, and by the subsoil-irrigation system. Both of these are too familiar to need elucidation. The new method involves a new principle; it cannot be found in books, only in fugitive articles, and buried in dry reports and archives. It is used and advocated by a few experts, seems to give satisfaction, and may be the coming system. It is called the method of intermittent downward filtration and is based upon the discovery that the soil does not become foul with sewage, if a certain time elapses between each deposit. In this interval the sewage-eating microbes have time to multiply and to dispose of the previous dose of sewage, leaving the soil pure and ready for the next deposit. The mode of obtaining this interval and the exact disposition varies in each case, according to the extent of the establishment and the nature of the available soil. The method is used for disposing of the sewage of whole towns as well as of single houses.

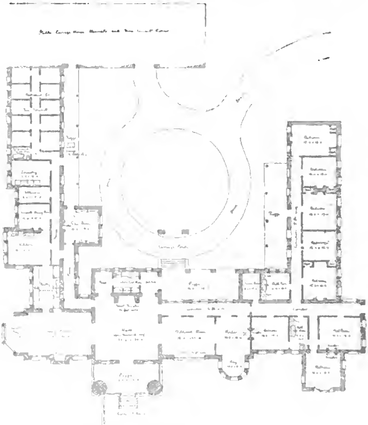
HOUSE AT HEMPSTEAD, LONG ISLAND.
[John Beverley Robinson, Architect.]

For warming the house, there is nothing on the whole that can equal the hot-air furnace. The complaint of dry air and overheating are faults in management that are not inherent in the

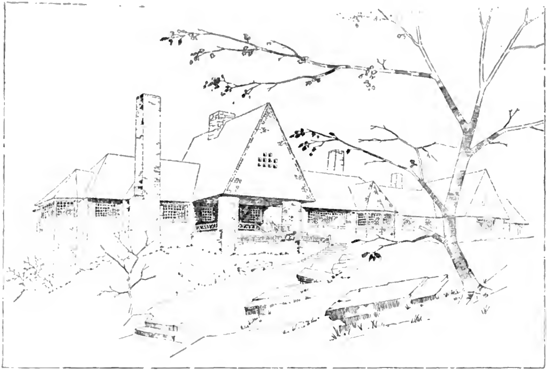


FIRST-STORY PLAN OF HOUSE AT HEMPSTEAD.

apparatus itself. The one great advantage of the furnace is the continual supply of good fresh air that it pours into the house. With ordinary fireplaces to serve as outlets for the displaced air, there is no better system of ventilation. When there is no fireplace, some kind of an escape for air should be provided, opening near the floor, and not at the ceiling. This is important, as where the opening is near the ceiling it simply drains away the hot air without disturbing the general atmosphere of the room. When it is near the floor, the air does not tend to escape by it until forced out by the pressure of the hot air accumulating in the upper part of the room.



FIRST-STORY PLAN OF SHOOTING BOX.



SHOOTING-BOX IN DELAWARE COUNTY, NEW YORK.

Hot water has many advantages. Although the first cost of the plant is greater, it costs less to run than any other method; there is not the overheating and alternate chilling of steam, or the escape of coal-gas to which furnaces are liable. If it can be arranged to admit air, it is better than the furnace. Sometimes this can be arranged by valved-openings through the walls behind the radiators, sometimes by a large hall register supplied with hot air from a radiator in the cellar. Steam-heating is not to be recommended for private houses, except by the indirect method, when it becomes to all intents a hot-air furnace. With both hot water and steam the disposal of the radiators is always a question. They are ugly things at the best, and even bigger and uglier for hot water than for steam; ugliest of all are the "decorated, marble-topped" affairs which some manufacturers admire so much. Apart from their inherent ugliness, the best place for them is the very place where they are least wanted,—just in front of the window. A reasonably good compromise is to put two radiators, one each side of the window, making the best of their inevitably objectionable appearance: this disposition, too, avoids the usual difficulty of the window-sill not being high enough to stand a large enough radiator against.

Pages might be filled with such considerations upon the fifty or a hundred items that go to make up a house: that which I chiefly wish to convey is that each way of doing each thing has its advantages and its corresponding disadvantages. The work of the architect is to balance these as best suited to the matter in hand, so as to secure a practically, esthetically, and economically harmonious result.

ELECTRICITY.

Conducted by Franklin L. Pope.

HE history of the invention of the modern incandescent electric lamp curious one. In 1878 the announce- nt, telegraphed all over the world, that ison had invented an electric lamp ich was to supersede gas as a domestic minant caused a wild panic among the lders of gas shares, who hastened to crifice their long-treasured securities at most any price. As it turned out, he d at that time done nothing of the kind, t early in 1880 he actually did produce e long-promised lamp. Patents were tained, companies organized, and a great siness rapidly built up. For six years serious efforts were made to enforce the tents, and meantime competing compa- es sprung up and flourished on all sides. hen came the beginning of a long, tedious, nd enormously expensive litigation, which t the end of another six years ended in e complete triumph of the Edison patent, hich was upheld in the court of last ap- eal. By due process of law the compet- ng manufacturers were one after another njoined, their factories closed up, and heir employés turned adrift. Suddenly ne of the concerns thus attacked turned upon its pursuer and aimed a deadly blow at the vitals of the Edison-lamp patent, alleging that the invention had not only been made, but had been publicly exhibited and operated in the streets of New York, by an obscure German watchmaker more than thirty years ago. The judge who first heard the new defense deemed the defendant's evidence insufficient, and declined to withhold his injunction, but on a second and subsequent hearing before another judge in another district an injunction was refused, thus rendering it necessary to have the whole case retried on its merits, in view of the new evidence. That the electric lamp alleged to have been made and used by the watchmaker is identical in all essential respects with the modern commercial incandescent lamp is admitted by all the experts, and hence the case is now narrowed down to the sole issue of priority of invention and public use on the part of Henry Goebel as against Thomas A. Edison. It goes without saying that the further proceedings in this most unusual case will command world-wide attention.

REFERENCE was made in these notes last month to the prevalent craze for the construction of electric street-railways, which is leading to the exploitation of them in many localities where there is no possible chance of their ever proving remunerative investments. The recently published annual report of the Massachusetts Gas and Electric Light Commissioners, containing the statistics of last year's operations of the electric-light companies of that State, shows that exactly the same thing has been done in that industry. There is an unwritten law, which in some cases has become crystalized in the statutes, which prescribes that the fare on an electric car shall be five cents, no more and no less, irrespective of the actual cost of the service rendered, and in like manner the price of electricity for illuminative purposes has somehow become established by custom at one cent per ampere hour. While it is possible that this rate might be found to be fairly remunerative in large cities or under exceptionally favorable conditions, the Massachusetts returns show conclusively that it is a ruinous one to the smaller enterprises, and that most of these, taking into account inevitable depreciation, must be running more and more behind with every year's operations.

OF the eighty-four companies engaged in supplying electric light and power in Massachusetts in 1892, only sixteen have been able to earn dividends of 6 per cent.

or more, while sixty-one have paid no dividends at all. Most of the smaller companies have already overloaded their plants, and are now confronted with the serious question whether it is worth while to add to their already unprofitable investment in order to accommodate new custom. Like the English sportsman in the jungles of India who has the tiger by the tail, they do not know whether it is best to hold on or let go. If they raised the rate to a paying point, which would probably necessitate an advance of 50 per cent. on the present figure, not only will they be denounced as conscienceless monopolists and extortioners, but their customers will in too many instances revert to their old-time habits of burning kerosene and going to bed at 9 o'clock. That the situation is a sufficiently serious one is shown by the fact that more than $1,000,000 has been invested in electric-lighting plants in various Massachusetts towns on which the net earnings at the present time, leaving repairs and renewals out of the question altogether, do not exceed 1 per cent. per annum. Yet the conditions of success and prosperity in this industry are, to say the least, fully as favorable in Massachusetts as in any other section of the United States.

IT is not difficult to foresee that there must ultimately be a severe check to the present electrical boom. An enormous amount of capital is being put into electrical enterprises of one kind and another which have no inherent possibilities of ultimate commercial success. The manufacture and sale of machinery and supplies for the equipment of all these non-paying electric-light companies and electric railways makes business lively and apparently prosperous for the time, but, when the inevitable day of reckoning comes, it is much to be feared that the financial results will lead capitalists to entertain an ineradicable distrust of legitimate as well as illegitimate electrical enterprises,—a consummation for many reasons greatly to be regretted.

AN immense dynamo has been installed at the aluminum reduction works in Neuhausen, Switzerland, which is driven by water-power derived from the falls of the Rhine at that place, and which supplies a current of 7500 amperes and 55 volts to the electric furnace. A notable peculiarity of the construction is that the main shaf
of the dynamo is vertical, and is couple
directly to the shaft of a turbine of 55
horse-power. The rotating part of th
machine weighs eight tons. It is probab
that dynamos of this general type will b
used in the Niagara Falls plant, now i
process of construction.

RECENT statistics give the aggrega
dynamo capacity of all the electrical cer
tral stations of London as 852,000 lam
of 8 candle power, of which about 504,0
have been installed. Taking the avera
of all companies, there are 1100 lamps p
mile of conductor. This figure vari
greatly, as might be expected, in differe
districts of the city. Only 23.7 per ce
of the total number of lamps are ever
use at any one time.

THERE are now eight municipal lig
ing-plants in operation in Great Brit
viz.: Bradford, Brighton, Dublin, Dund
Glasgow, Hull, St. Pancras, and Taunt
The aggregate population of these ci
is over 2,000,000. Municipal plants are
in process of erection in Bristol, Manch
ter, and Portsmouth, and proceedings
their establishment are being taken
number of other cities.

AN experimental railway 1⅛ miles
has been constructed on Long Isl
which is to be equipped with electri
operated cars arranged upon the prin
of the bicycle. Each car is suppo
upon two grooved wheels arranged
and-aft and running upon a single
Parallel to the track-rail and nine
above it is the guide and trolley rail.
car is 65 feet long and weighs abou
tons. The driving wheel is five fe
diameter, and is provided with a p
direct-coupled electric motors, capa
developing 75 horse-power at 560 re
tion per minute. It is expected

d of 100 miles per hour will be attain- .

HE German military authorities have n experimenting in electric illumina- from captive balloons, with a view to employment of the method in siege rations. A light of 5000 candle power ed at a height of 600 meters was found ight an area of 500 meters in diameter most satisfactory manner, while half ile of road was lighted from a height 150 meters.

N some of the Glasgow ship-yards an ctrically-driven rotary planer is now ed for smoothing the decks of ships,—an eration which when performed by hand exceedingly laborious. The machine oks like a lawn-mower and is handled in uch the same way. This suggests that ere the invention of an electrical lawn- ower would not only meet a long-felt ant of the suburban resident, but would the same time assist in improving the ad curve of the local electric-lighting ation.

A SOMEWHAT singular scheme for elec- ric lighting has been proposed by a rominent electrician for the city of Bel- ast, Ireland, the adoption of which may ot be improbable. A number of independent electric stations are to be placed in different districts of the city, the motive power for which is to be furnished by gas-engines. There are some things to be said in favor of such a plan, but on the whole, in enterprises of this kind, a policy of concentration has been found to lead to more economical results than one of dispersion.

THE experience of managers of electric plants in the States along the Atlantic seaboard have drawn attention to the singular fact that thunderstorms are largely a result of peculiar local conditions. Instances have been known of two stations less than fifty miles apart in one of which troubles and interruptions from lightning during the summer months were almost incessant while the other was almost entirely free from any such disturbance.

A NEW manufacturing establishment recently completed in New Jersey has been equipped throughout with electrical appliances for the distribution of power, shafting and belting of every kind being wholly dispensed with. Thick copper rods extend throughout the buildings, which are tapped, whenever required, to furnish a supply of electricity to the motors, with which each separate machine in the factory is equipped. Careful computations show that the loss of power in transmission is much less than by any of the old methods.

SOME very interesting tests have been made at Johnstown, Pa., with an apparatus for electrically welding the ends of rails, after they have been placed in position in the track. It is found that about three minutes is required to bring the abutting ends of the rails to a white heat; the ends being then brought into contact under a heavy longitudinal pressure, a perfect weld is effected without difficulty. If the use of a jointless continuous rail should prove to be open to no objections on the score of expansion and contraction under changes of temperature, it will not improbably constitute one of the most important improvements which has ever been introduced in the construction of railways.

ACCORDING to the electrical journals another attempt is to be made to operate one of the New York city street railways by storage batteries. A section of the Second-avenue line is to be equipped exclusively with electric cars, for which a complete and well-designed plant for charging and handling the batteries has been erected. The enterprise is apparently in competent hands, and is said to have strong financial backing. It is certainly to be hoped that this undertaking may be more successful than its predecessors.

A STORAGE-BATTERY of seven cells exploded in Washington, D.C., while in the process of being charged, a spark caused by an interruption of the circuit having set fire to the uncombined gases in the cells. The explosion was a violent one, but fortunately none of the attendants were injured, beyond being deluged with dilute sulphuric acid.

THE annual report of the General Electric Co. to February 1, 1893, shows 1277 central stations using apparatus supplied by it, operating about 110,000 arc- and 2,500,000 incandescent-lamps. The company has also furnished apparatus for 435 electric railways, aggregating 4927 miles, and operating 8356 cars. Two electric locomotives of 1600 horse power each, ordered by one of the principal trunk-lines,—presumably the Baltimore and Ohio,—are nearly completed.

EXPERIMENTS are being made in Chicago with an electrically propelled vehicle for ordinary street use. The wagon weighs 2500 pounds, and the power is supplied by a storage battery weighing 850 pounds. In view of the ill success which has hitherto attended all attempts to operate street-cars profitably by means of storage batteries, we do not look for an immediate and radical revolution in the methods of ordinary street transit as the result of this application. Yet the time will doubtless come when substantially all highway traffic will be carried on by electric power.

ONE of the most famous exhibits at the Electrical exhibition in Philadelphia in 1884 was the "jumbo" dynamo of the Edison Electric Light Co., which had a nominal capacity of 1200 16 candle-power lights, and was at the time regarded as a remarkable achievement. The art of dynamo designing at that date was not very well understood, and hence it is not to be wondered at that the weight and bulk of this machine, as compared with its output, was excessive. Within a short time other dynamos of equal capacity were designed, whose gross weight was little if any more than that of the armature alone of the "jumbo." The progress made in the art during the eight years which have elapsed since the building of the "jumbo" is strikingly illustrated by the central exhibit of the electrical station at the World's Fair, which consists of a 2000 horse power engine belted to two immense dynamos, having a capacity of 10,000 light each.

A NUMBER of the most expert tele graphic operators of the country have re cently participated in a competitive priz exhibition, at which some really remarka ble work has been done. E. D. Moore, i one trial, transmitted 234 words in five mi utes without an error, which is at the ra of a word in 1.3 seconds. To apprecia the wonderful skill of this performance is necessary to inform the layman that th average number of distinct movements the wrist and hand to form a single le ter of the telegraphic code is six, and th ordinary words will average at least fi letters each, and hence that Mr. Moo was compelled, not only to make no le than twenty-three distinct muscular mov ments per second, for a period of five mi utes, but each of these movements mu have been timed with extreme accura seeing, for instance, that a variation of 1 of a second in timing might have convert the letter "i" into "o," or "c" or "r" to "s." Very nearly as good work was do by Mrs. E. Sandberg of the women's cla

THE legislature of Massachusetts affixed a proviso to every street-rail charter which has been granted during present session that the road shall not sold or leased to a foreign corporation. is not unlikely, however, judging from p experience, that some way will be found evade this proviso. It will be remembe that during the past year the control some of the most important electric str railway systems of that State have pas into the hands of a New Jersey cor ration.

A BILL is pending in the Massachus legislature, which will probably becom law, providing for the placing undergro of all the electric wires, with the excep of trolley wires, within the business por of the city of Boston. It is provided the work shall be supervised by a com sion, composed of the city engineer, superintendent of streets, and the inspe

wires, and that the work shall be com-
ted by January 1, 1900.

HE aggregate receipts of the electric-
ht central stations of Massachusetts for
year ending June 30, 1892, is reported
the State commissioners as $2,970,-
7.94, and the expenses as $2,015,402.86.
arly all the money has been made by a
zen or so of the larger companies, the
aller ones, as a rule, being rather un-
ofitable enterprises. The number of in-
ndescent lamps in service foots up 224,-
6, as against 161,259 in 1891, and 118,529
1890. The number of gas companies
hich have also undertaken to supply
ectricity is 23. A considerable number
f towns have taken measures looking to
ne establishment of municipal plants for
he supply of electricity, both for public
nd private purposes, and some such plants
ave already been installed, though with
what result it is yet almost too early to
etermine with certainty. The number of
atal accidents during the year was 4, of
which 3 occurred to employés through their own carelessness, and the other to a citizen who foolishly put his hand on a live wire out of curiosity. In six cities a considerable portion of the lines in the thickly-settled portions are in underground conduits. The returns of the gas-companies show that their receipts for the sale of gas by meter still continue to increase, in spite of electric competition, though there is a marked falling-off in the receipts for gas furnished to public lamps, the arc-lamp being apparently preferred for street lighting in all places where it is available.

A NEW standard cell for the determination of electromotive forces has been devised by Edward Weston, which is free from the temperature error of the Clark cell. He makes use for this purpose of the salts of cadmium, which, when in solution, retain the same density through a wide range of temperature. Mr. Weston's tests show that the variation in electromotive force in such a cell does not exceed 1-100 of 1 per cent. through a range of over 200° F. It also happens very conveniently that the electromotive force of the cell is nearly unity, being in fact 1.019 volts.

THE city of Topeka, Kansas, has a municipal electric-lighting plant which cost in the aggregate $55,447.98, and comprises 184 arc-lamps of 2000 nominal candle-power each. A return exhibiting details of cost and results of operation for 38 months has been published, from which it appears that the aggregate hours run was 7622.8 and that 5078 tons of coal costing $13,924.64 were consumed. The entire cost of operating the plant, inclusive of interest on cost at 6 per cent., insurance, and repairs for the above period, was $54,240.95, making the cost per lamp per month $7.75 and per hour 3.86 cents. The cost of coal was almost exactly one-fourth of the total cost of operation. The figures are given in great detail, and the whole is a valuable contribution to the discussion now going on as to the actual cost of electric lighting.

AS an argument in favor of the use of electricity as a motive power for traveling cranes may be cited the crane built by the Yale & Towne Manufacturing Company, at the Columbian Exposition. The Machinery Hall is divided into three bays, each covered by an electric traveling crane, the above-named crane occupying the central bay. The crane has been in active and constant operation day and night, handling the heavy materials and installing exhibits since the middle of December, 1892, and not only has it done its own work in the most thorough and satisfactory manner, but has been engaged in handling the exhibits for the side bays, pending the starting of the cranes covering those portions. The great success with which this powerful crane has done its work is ample demonstration of the value of the use of this new motive power, properly applied to correct design and excellent workmanship, and would seem to conclusively prove that the electric traveling crane is the crane not only of the future but of the present.

MECHANICS

Conducted by Leicester Allen.

THAT splendid material realization of the ever-increasing accumulation of knowledge, science, and mechanical skill, built up by generation after generation of mathematicians, metallurgists, physicists, philosophers, chemists, and mechanicians, the steamship *Campania*, and her scarcely less famous rival the *Paris*, while these words are being penned, are starting on what are destined to be voyages of the most intense interest and importance to naval architects, marine-engine builders, mechanical engineers, and shipbuilders in all lands. This interest and importance does not rest in the fact that one of the ships is owned by an American company while the other is an English rival, though this has some significance with reference to the future of American shipping interests. Both these magnificent ships were built and equipped in foreign shipyards, and neither of them is typical of American marine construction. What these voyages are to indicate is the possibility of speed in transatlantic navigation, of endurance under steam pressure but recently thought practicable, and under increased strains to machinery due to the unprecedented power applied to propulsion. To naval architects the records of these two voyages will supply data to guide them in the modeling of other rivals yet to come; for we have not reached the ultimate, either in modeling ships or in engine-building; and, as has previously been asserted in this Department, there is no doubt that higher speed in ocean navigation than has yet been reached will be attained whenever such speed can be shown to be commercially profitable.

THE event above noted, together with the remarkable maiden voyage made by the *Campania*—the quickest first transatlantic trip ever made by any ocean-steamer—and the magnificent display of warships in the recent great naval parade and review in New York Harbor, have combined to focus public attention upon progress in marine engineering in a very notable manner. And yet most people have as yet but a feeble notion of what one of these great marine structures really means. Such a ship as the *Campania* is a miniature world in the respect that on it may be found something of everything produced by the art of man. Of anything the human race has been able to learn, or to execute, through the ages that have rolled away into the far past, some requisition has been directly or indirectly made to give to the world the steamship of the last decade of the nineteenth century. Nothing, even the magnificent collection of buildings of the World's Columbian Exposition, with innumerable contents collected from all lands, can be mor inclusively representative of man and hi mastery of natural materials and force than a modern steamship; particularly warship, that carries in her hull imprisoned forces which, if unrestrained, coul wreck a city as completely as it could b destroyed by an earthquake. In this connection the description of the *Campani* given by a Clyde engineer in the preser number of this Magazine may be mentione as giving in a concise, popular, and reac able form a graphic picture of the mechan cal structure and machinery of a ship s well built in all parts that the first time sh crossed the ocean she could break a records for maiden trips, making the vo age in 6 days, 8 hours, and 34 minute at one time achieving a speed of 503 kno in 24 consecutive hours, and in one of h remarkable spurts reaching a speed of 2 knots per hour,—a speed never belo reached by any steamship.

SINCE the above lines were placed type, the *Campania* has completed t ge, and has exceeded every other rec- made on a trip from New York to enstown,—the time being 5 days, 17 rs, and 42 minutes. Her best daily run 517 miles. It remains to be seen now ther she will eclipse the best westward record, which is that of the *Paris*. If should succeed in this, it is not to be ected that she will long retain the nor of being the fastest steamship afloat. ere are others yet to come after her it will probably cut off more of the time w necessary for a transatlantic passage.

ANENT non-rotative steam pumping en- nes, Mr. d'Auria, at a meeting of the ngineering Association of the South, eld at Nashville, Tenn., on April 13, ade some interesting remarks. The eaker argued that, apart from any con- deration relating to expansion, the aggre- ate weight of the reciprocating parts in he Cornish engine is 2.3 times the weight f the load, in the Bull engine equal to he load, and in the Worthington one- enth the load; though it could be made eavier without restriction; but, with reduction of weight in these three successive types of engines, the rate of steam expansion had also to be reduced, it being possible to use in the Cornish engine four expansions, in the Bull but two, while in the Worthington *simple cylinder* expansion was practically impossible. Mr. d'Auria showed that the piston speed is affected by what he calls "effective weight," this weight being expressed by the sum of the products of each of the reciprocating parts by the square of the velocity of its center of gravity of gyration, expressed in terms of the velocity of the plunger as a unit. In using steam expansively, this force in the first part of the stroke is greater than the load and will perform an excess of work, "accelerative work." According to a law which Mr. d'Auria claims to have discovered, the mean plunger speed during the stroke in a non-rotative pumping engine equals

$$c\sqrt{\frac{\text{accelerative work}}{\text{effective weight}}}$$

the coefficient, c, varying with the variation of the propelling force and in the average equaling about 4.8. By the application of this law it was sought to prove that the Bull engine could have been made lighter and yet have used a higher rate of expansion than the Cornish; that a Worthington engine could have been transformed into a high-duty engine by adding a reciprocating weight, about 7 or 8 per cent. of the load, and moving with a velocity four times greater than that of the plunger. This added reciprocating weight, which constitutes a high-duty attachment, was shown in the form of a liquid column; thus, a direct-acting plunger is attached to an extension of the piston-rod of the pumping-engine and moves in a cylinder of its own; at the ends of this cylinder the ends of a U-shaped pipe are attached, and the cylinder and pipe are filled with liquid. The area of the pipe being less than that of the plunger, the velocity of the liquid column is proportionally greater than that of the piston. Shocks due to excess of energy at the end of the stroke are prevented by passing the liquid around the plunger through small channels uncovered —when the plunger, by this excessive pressure, passes beyond its usual stroke. This feature, as well as an illustration of the law of piston speed, were experimentally shown by a model in which the propelling force was a spring attached to one end of the plunger-rod, the load being represented by a weight pulling at the other; these balanced only at the middle of the stroke; the pull of the spring at the beginning was about twice that of the weight, and at the end only equaled the friction of the working parts. When the apparatus was filled with liquid, the piston made a steadier, longer stroke than when no liquid was used, showing the friction of the liquid to be insignificant. Diameter of the plunger, 3.94 inches; diameter of pipe, 2.06 inches; ratio of their areas, 3.65; weight of moving parts, 61 pounds; weight of water in the pipe, 51.5 pounds; hence the effective weight with the water is $W = 61 + 51.5 \times 3.65^2 = 747$ pounds, and without the water is only $W = 61$ pounds. The accelerative work in both cases is $Q = 4.84$ foot-pounds, and the length of stroke 0.46 feet. The velocity was found to be, with the water, 0.383 feet per second and, without the water, 1.33 feet per second. According to Mr. d'Auria's approximate formula,

$$V = 4.8\sqrt{\frac{Q}{W}},$$

the velocities equal 0.384 and 1.34 feet per second, respectively, showing close agreement with experiment. Besides, the figures show that the effect of the water in the pipe was to reduce the piston speed to about one-third that without water, and that without appreciable loss by friction.

The above is condensed from a communication obligingly forwarded to the editor by Mr. Walter Kirkpatrick, secretary of the association.

A LIVELY debate on the important subject of the circulation of water in steam-boilers has grown out of a lecture delivered recently by Mr. George H. Babcock, of sectional-water-tube-boiler fame, at the Cornell University. In this debate the principal disputants besides Mr. Babcock as yet have been Mr. Fritz Krauss of Vienna and Mr. John J. Hogan, the latter being an engineer of repute and one who has given much attention to the construction of steam-boilers both for heating and power purposes. Mr. Krauss also is an engineer of creditable attainments. Of Mr. Babcock's ability to discuss a question of this kind it is wholly unnecessary to speak, as for years he has stood at the head of a firm widely known both in the United States and in Europe. Now it has come to pass that Mr. Krauss differs with Mr. Babcock on the questions discussed in the lecture referred to, and Mr. Hogan differs with both Mr. Babcock and Mr. Krauss. The doctors thus disagreeing, one must be cautious in attempting to decide the question in dispute. The debate has been carried on with spirit in the columns of *Power*, and is far too voluminous and technical for even a partial review here. The principal bone of contention appears to be propositions made by Mr. Babcock in his lecture, which are, in substance, that an admixture of steam in water tends to increase its velocity of circulation up to a given limit, this limit being reached when the rising column is all converted into steam, and that the maximum weight of water circulated will be when "the density of the mingled steam and water in the rising column becomes one-half of the solid water in the descending column, which is nearly coincident with the condition of half steam and half water, the weight of the steam being very slight compared to that of water." Mr. Babcock's lecture is notable as probably the first attempt at the systematic investigation of the circulation of water in boilers by the application of mathematical methods to experimental data. Far too little is known of the real state of things in boilers generating steam. On the othe hand, Mr. Hogan is known to have devoted much time in the performance o ingenious experiments relating to the subject; and in the April number of *Power* h has described and illustrated quite a serie of such experiments, the results of whic are opposed to the accuracy of the princi ples enunciated by Mr. Babcock.

Mr. Krauss attacks Mr. Babcock's prop positions on mathematical grounds, whil Mr. Hogan, regarding steam bubbles a bodies of gas confined in films of wate and as having expansive force in all dire tions, maintains that their formation an presence in steam-generating tubes is a obstruction to circulation, and that th circulation of water in a tubular system always less when steam is forming tha when the water is solid. It must be co fessed that the experiments adduc by Mr. Hogan as proving this theor as well as an anomaly in the circulation water that occurred in a water-tube boi installed by a firm in New York city, see convincing that something like what claims to occur does actually take place boiler circulation, to-wit: that the presen of steam in tubes, instead of acting gether with gravity to increase, acts agai gravity to decrease the velocity of the c culating water. But are these experime conclusive in establishing Mr. Hoga theory? They were performed in gl tubes of small size, and in such tubes ca

ty is a considerable force. A bubble
t would form in a small tube and fill it
ld easily detach itself and float up
ough a larger column. If it were pos-
le to repeat Mr. Hogan's interesting ex-
iments in transparent tubes of a size
nparable to those actually used in water-
e boilers, we should probably soon
ow by actual observation the true in-
rdness of boiler circulation, which up to
present time has eluded direct obser-
tion, and is only inferentially known, if,
deed, it can properly be said to be known
all. Mathematical methods proceeding
om experimental data may fail if there
any defect in the data. On the whole,
e question of the exact action of water
hen steam is forming, except in open
essels and in small transparent tubes, is
et unsettled. Many general principles are
nown, but anomalies occurring in the ex-
erience of every steam engineer point
learly to the fact that we are far from
omplete knowledge. Now that the sub-
ect has become a live one, it is to be
oped that the interest aroused in it may
not subside till some ingenious experi-
menter has contrived a way to force nature
o reveal her secrets in steam generation,
clearly and unmistakably.

"THE battle of the gages" was a phrase familiar to railway-men and to mechanical engineers twenty years ago, when the technical press teemed with discussions upon the relative values of broad and narrow railway gages. Neither the broad gage track, such as the New York and Erie railway made the serious mistake of first adopting, thus incurring an enormous expense for change to the present standard width of track a few years later, nor a gage narrower than the one now used, which also had numerous and strenuous advocates, survived the controversy, with the exception of a few narrow gage tracks used for special purposes and wholly disconnected with any of the great lines. Now a new battle of gages is on, but this time it is wire-gages that are giving rise to contention. Many and loud have been the complaints in the mechanical world that the existing lack of uniformity in wire-gages gives rise to never-ending perplexity and inconvenience. Though the contention has not been confined to the medium of any single journal, there has been, perhaps, more said and well said upon the subject in the *American Machinist* than in other papers among our exchanges. This paper has placed itself in the van of reform in the matter, and has opened its columns widely to communications upon the subject, some of which have shown much ability and a comprehensive grasp of the difficulties that present themselves whenever a radical reform in mechanical methods or appliances is proposed.

There is, perhaps, just at present no question before the mechanical and manufacturing public that might by hasty and ill-considered legislation be made to give greater annoyance than this could. The numerous gages already in use are sufficiently worrying, without the addition of a new one as defective as any of them. The American Society of Mechanical Engineers has taken up the subject and referred it to a committee. Associations of iron and steel workers have urged the adoption of a new table of United States standard gages, and have pushed forward the proposition so energetically that they have got it before a congressional committee. Clearly the legal establishment of a uniform scale, if reasonably free from defects, would be very desirable; but Mr. Oberlin Smith, one of the committee appointed by the American Society of Mechanical Engineers, has criticised the proposed scale with great force in a recent number of the *American Machinist*, showing absurdity after absurdity in it, and calling for concerted action to prevent its being saddled upon the country by hasty, injudicious, and ill-advised legislation. This department has not the space for a résumé of the objections raised by Mr. Smith; but they are very forcible, appealing to common sense in a manner that, it would seem, must inevitably influence the final decision of the question adversely to the proposed new scale.

A GREAT loss to the country as well as to the American Society of Mechanical

Engineers has resulted from the destruction of the records of the society's committee on standard methods of testing. These records were in the office of Mr. Gustavus C. Henning, a member of the committee, when the recent fire occurred in Temple Court building in New York city, a fire that, notwithstanding it broke out on an upper floor of a building hitherto claimed to be fireproof, did much damage to the building and burned up much of the effects of its occupants. The data comprised in the records destroyed were of very great importance, being derived from years of work on the part of Mr. Henning; and their loss will indefinitely delay the completion of a valuable and important work upon which much time and labor have already been expended.

AMONG the new books that have made their appearance this year is one on "Pumping Machinery,"* by Mr. William M. Barr. It is an octavo of 447 pages, printed in clear bold type, on good paper, and profusely illustrated. One of its best features is a copious and well-prepared index, a feature of technical books that too often is not given the attention it ought always to receive. The book is to pumps what Seaton's "Marine Engineering" is to the marine engine, and those familiar with the last named treatise will hardly need a higher recommendation for Mr. Barr's work, which is both theoretical and practical, entering thoroughly into the details of pump construction as well as principles of their action. The discussion of the subject of suction and delivery-pipes contained in Chapter VI. is enough in itself to produce a favorable impression of the entire book, yet, though this chapter is of great practical interest, one turns over into other chapters only to realize the same satisfactory sense that, while the book is extremely thorough, there is nothing superfluous in it. Did space permit a review of this excellent book in this Department, its merits would certainly entitle it to such treatment; but whoever, feeling the need of a thorough and exhaustive work on pumping machinery, accepts the opinion of it here given as a warrant for its purchase is not likely to be disappointed.

THE preservation of timber from the assaults of the *Teredo navalis* is said to have been successfully accomplished by a process discovered and subjected to trial a the Gig Harbor lumber mill, Puget Sound The method employed is said to proceed o an entirely new principle, to-wit: the starvation of these destructive worms rather tha their destruction by poison, as has bee heretofore attempted. It is claimed b the promoters of the method that th worms penetrate the timber simply fo food, of which, in its natural state, wood a deposit; and that the new proce merely unfits timber for the food of th teredo, while, at the same time, the us fulness of the timber remains wholly unim paired. The details of the process are n given, but an account of some tests of efficiency is very encouraging, if it not in any way exaggerated. A solution some sort is used, by which the nutriti character of the wood is changed so th the worms do not touch it. A stick timber so treated is alleged to have be sunk in Gig Harbor for more than a yea and, while a stick of the same timber n so treated but tied to the prepared sti was wholly destroyed, the timber that h been treated was not touched. Other te have been made, the results being report as similar to that made in Gig Harbor. all this proves to be true, the inventor the process has conferred a great ben upon the human race. It would be h to estimate the loss in the destruction timber used for wharfs, docks, etc., an ally resulting from attacks of the tere which such an invention as is here scribed might prevent.

***Pumping Machinery*. A Practical Hand-book Relating to the Construction and Management of Steam and Power Pumping Machines By William M. Barr, Member of the American Society of Mechanical Engineers. With upwards of 260 engravings, covering every essential detail in pump construction. Philadelphia: J. B. Lippincott Co. 1893. [Price, $5.]

ARCHITECTURE.

Conducted by Barr Ferree.

T is well, now and then, to briefly survey the educational field in architec- re, and, June being the month of exami- itions and commencements, there can be o better opportunity than the present. he education of the architect is clearly ne most important part of his career. In his period he learns the elements of what e knows and lays the foundation of his fter work. His future monuments, be hey good or bad, have their origin in this poch, and the ideas drilled into him then, he models he then learns to think about nd copy after, are the models of his later work. And incidentally they help to make the lives of other people, and even other generations, good and pleasant or uncomfortable and disturbed, according as they are good or bad and he has learned his lesson well or ill. Architectural education in America, as has been so often pointed out in these pages, is rapidly getting into the French rut, which the professors and many others think a very fine and satisfactory rut to be in. Satisfactory or not, it is a rut nevertheless, and we have yet to learn that the wheels of progress can move forward in ruts of any sort. Among the educational forces active in forcing the French exotic upon us the *Architectural Review* of Boston must be counted as a powerful one. Originating as a students' journal in the architectural department of the Massachusetts Institute of Technology, it has labored for the French method with untiring zeal. In looking through the early volumes of its immediate predecessor (the *Technology Architectural Review*) recently, we found the following passage, which is well worth quoting as illustrating the trend of architectural educational thought current in this country. In speaking of the appointment of Professor Chandler to the headship of the department it says (Vol. 1, No. 4): "We may hope that the pupils, *instead of being occupied with the design of simple modern and utilitarian buildings* (the every-day work of a modern office), will rather be led to concentrate their studies on proportion, scale, historical precedent, and those principles which underlie all design in every style." The italics are ours, and very wonderful words they are. We do not know whether the author of this sentence is the present editor of the *Review* or not, but its policy is apparently in line with this monstrous utterance.

We use the word advisedly, with a full sense of its meaning and all that it implies. Architecture is not a theoretical but a practical art. Those who practise it are not dreamy artists intent only on giving form to the products of their imagination. They have other things to do than sit in their offices all day long and think, with a pencil in their hands, putting gorgeous fantasies on paper and going into ecstasies over the result, either with themselves or in their capacity as the corporate members of a mutual admiration society. It pleases many of them to call themselves artists and delegate the practical details to another member of the establishment, but the successful architect, like every other successful business man, must be a sharp, shrewd fellow if the world is not to get the better of him. And so, although the sentence we have quoted very well illustrates the ideas of the Frenchites,—if such a barbaric word may be coined,—it is monstrous because it expresses the elevation of the theoretical over the practical, and deliberately calls for the extinction of practical ordinary every-day work because it is so. Is it any wonder that under the guidance of such authority every-day work is full of blemish? Is it any wonder that our architects cannot design successful business buildings when their training distinctly, deliberately, and openly ignores the possibility of such problems? Architecture is not an art of the clouds; a very terrible thing happened to the only people we know of who tried to build up to these lofty heights, and very much the same thing is happening to American architecture because the teaching of it is not brought down to the level of the foundation. Young men are drilled in the designing of monumental theaters, of palatial residences, of spacious municipal buildings, of impossible crematories, chapels, cathedrals, churches, casinos, music-halls, and what-nots, all prepared on the most gigantic scale, all erected on sites of unlimited areas, paid for with unnumbered pots of money, and carried into execution with the utmost disregard of the consumption of time and energy. Very fine, is it not, and very thrilling to boot, to be sat down, after three years of this sort of thing, to the designing of a $1200 stable or a $2500 country house? And yet the professors would have it that practical things are not in it. The more fanciful a program is, the more unlikely the conditions, the better it is for study. Is it right? We think the word monstrous a better one to apply to it. It is this neglect of ordinary things that makes our everyday architecture so ordinary and wearisome. For a practical people, intent on practical things, doing things in a practical way and for a practical purpose, we certainly permit our architectural education to be managed on a very singular basis.

THE advocates of the unpractical in arcitecture,—for under this head the *Technology Architectural Review* must be classed,—will find a striking commentary on their system in an article on "The Practical Limiting Conditions in the Design of the Modern Office Building," which Mr. George Hill contributes to the *Architectural Record*. This is one of the most notable contributions to current architectural literature made by any writer in the last few years, and may be profitably read by every professor, every student, every architect, draftsman, real-estate man, and investor, for the author has condensed a vast amount of information in an interesting and accessible way, and supports his principles by a mass of figures based upon much calculation and careful observation. It is quite time, in the present mania for high office buildings, that all concerned in their production should know there are certain practical limitations beyond which the architect cannot advance if they are to be a paying investment. Doubtless the advocates of the unpractical will cry aloud at the thought of financial return influencing any sort of building in any sort of way, but if they will tell us what building has ever been erected that did not have to be paid for in some shape or another we will be obliged to them. Whether they like it or not, the financial profit of high office buildings is the criterion by which they are judged and the success determined. But this is not all. Mr. Hill points out the elements that must be combined in the successful building as (1) eas of access, (2) good light, (3) good servic (4) pleasing environment and approache (5) maximum of rentable area consisten with true economy, (6) ease of arrangement to suit tenants, and (7) minimum c cost consistent with true economy. A of these points are treated at considerabl length, with ample illustration and con ment, and the part they take in makin the building a success is clearly dete mined.· An especially valuable feature this article is the series of tables, pr pared by the author, giving, in convenie form, comparative costs for buildin built on the brick or steel systems, carri to different heights, built on various siz lots, and numerous other details of simi practical value. If the *Technology Arc tectural Review* is a safe guide, such thi as this are not fit or proper subjects the young and tender minds in the arc tectural schools. Only after they begin fight for themselves and realize h very little they do know, and how v theoretical most of that is, can they app ciate such solid realities as Mr. Hill ser up to them. Yet we do not think we be wrong in suggesting that a cours lectures on this subject—and why not this author?—would be a most valu addition to the curriculum of any architectural school. We commend this suggestion to the conductors of our architectural schools.

THE Municipal Art Club, which has recently been organized in New York, has laid out for itself a program of considerable proportions. It proposes to raise a fund, by means of membership dues, for the decorations of public buildings and the providing of works of art for public localities, both through competitions and by means of direct purchase or commission. Organized by painters, who largely predominate in its membership, it marks a new feature in municipal art in this country. In an organization of this sort, in which the majority of the membership must necessarily be laymen, the question of the layman's function is likely to occupy an important place. And in truth it is right that it should, for, admirable as the purposes of the club are, appealing as it does to the best element of New York's cultured population, it is still too much to ask that the men who contribute the bulk of the club's income shall have no right or parcel in its management, or do anything but vote the professional members into office year after year. The question brings up the whole subject of the layman's place in art, his right to his opinions, and his justification in passing on the work of his professional brother. It is an undoubted fact that many laymen are grossly incompetent to criticise any sort of artistic production; but it is likewise unfair to include all outside the sacred pale of art in this miscellaneous category. Art, and especially public art, cannot improve so long as the artists wrap mantles of superiority around themselves and refuse to have more than a speaking acquaintance with laymen. Mutual intercourse is the key to mutual improvement, and the Municipal Art Club has an unrivaled opportunity for helping the cause of the distribution of artistic knowledge by welcoming the laymen to its ranks, not for their dollars alone, but for the help and encouragement each can give the other. Caste distinctions have no place in American civilization, and artists should not jump too heavily upon those who, if they are of no other use in the world at least provide them with the means of making a living.

AT the recent dinner of the Department of Architecture of the Brooklyn Institute one of the members called attention to the fact—amazing to him—that, although the Department was then passing through the trial of a competition, in which many members must necessarily be disappointed, they were sitting down together in friendly converse without a thought of putting poison into each other's cups or otherwise misbehaving themselves. We do not know how extraordinary this self-control may have been for Brooklyn, but certainly it would not be considered out of the way in many other communities. But this remark suggests something more than a commentary upon Brooklyn table manners. Why should rival architects, engaged in a competitive business of any sort, think it an amazing sign of grace to meet their fellows in friendly talk? Every day and every hour business men in all walks of life are doing the same thing, and we quite fail to see any reason why architects, even though we call them artists, should be exempted from this common every-day rule. Whatever architecture may be in theory, it is clearly enough, in this day and generation, a matter of business, and the architect measures his success by the amount of his business, not by the personal gratification he derives from it or by the number of soul-thrills he undergoes annually. It should not, therefore, be necessary for the architect to look upon his fellow-workmen in the light of hated rivals, to think to turn down another street when he sees them passing, or to hint of poison when chance throws them together in a convenient restaurant. But as an offset to this there is the indisputable fact that no other class of business men—call them professionals if that be more acceptable—conduct their work,—labor, occupation, business, art; take your choice, it is the idea, not the word, we are concerned with,—on the competitive system, in which all or a number fight for the same job, at vast personal expense and very considerable mental worry, which does not a little to deteriorate the architectural standard of the country. Other business men may cut prices, may offer greater inducements in the quality of their goods, in the time and manner of payment, and a host of other legitimate expedients constantly practised by most successful business houses. There is none of this for the poor architect. He may not charge more than a fixed schedule, and, while the quality of his work may be better than that of his neighbor's, it is only by presenting a pretty picture that he is able to suggest the fact. Perhaps, after all, to men doing this sort of thing every day in their lives a suggestion of poison at a friendly banquet may not seem strange. Under the mental strain occasioned by such a method of existence almost anything can be excused and accounted for.

THE World's Columbian Exposition at Chicago is unquestionably the greatest architectural event of the year. Notable in many ways and from many causes, this great exhibition is more notable for its architecture than for any other single element. It marks a new feature in the popularizing of the art and is especially remarkable in showing the vast growth architecture has made among the people of America as compared, for example, with the Philadelphia Centennial Exhibition. The tawdry ugly structures of that show doubtless did considerable good in the way of serving as an example to the managers of the present exhibition of what not to do. This in itself was considerable, but the enormous expenditures of the Columbian Exposition have been largely caused by an attempt to produce an artistic architectural *ensemble*. Every one knows,—and the people of Chicago most of all, perhaps,—that the palatial structures on Lake Michigan were not essential to the success of the exhibition. Desirable as splendid buildings always are in exhibitions of this sort, it is not the buildings themselves that are on exhibition, but their contents. Any building that will safely house the exhibits and permit their display in a satisfactory manner fulfils the end of an exhibition building quite as fully as the most gorgeous structure devised by human hands. But the managers of the World's Columbian Exposition were not satisfied with utilitarian buildings alone. They recognized the value of an artistic group of buildings, and so wisely have they planned that the Chicago Exposition buildings are now the most-talked-of structures on the earth. And the most remarkable part of the enterprise is that some $18,000,000 has been expended in this practical unartistic country of ours for buildings most of which will only be used half a twelve-month. Never in the history of the world was so gigantic an expenditure made for so short a time, and the wonder of it is that it was, most of it, for architecture, the one art of all others we are apt to consider ourselves behind in. No Roman emperor in the plenitude of his power ever conceived so vast a festival as this which is now being celebrated in this land of the people and the free. It marks a new epoch in the evolution of American character and American taste and above all in American architecture Surely among the final results of this grea enterprise its influence on the future o American architecture must hold the firs rank. People who never talked of architecture talk of it now, and the fact that there i such an art—a real art and a true one—wil be made manifest to many minds wher before the very conception of it was impossible.

APROPOS of the World's Columbian Exposition, what a pity it is it is not mor generally called by its full and official titl It has become the custom to speak of it, i many quarters, as the Chicago Fair, method of nomenclature which has don it positive harm in foreign parts, sinc until this great enterprise was undertake the good city of Chicago was not so we known to the inhabitants of the earth an of space generally as it is now. Th contemptuous treatment of the fair in i early stages by a large portion of the easte press likewise helped to make the Expos tion seem local among those who have n yet learned to estimate the utterances the newspaper press at its true value, if anything closely approximating zero may be said to have a value. But now that the Exposition has fairly opened, this provincialism—in which metropolitan organs were most active—is rapidly disappearing, and even the daily newspapers are beginning to recognize the fact that the Exposition is not Chicagoan at all, but the World's. This however has not prevented poets and other dabblers in architecture from devising names of their own for it which have attained more or less publicity. One of these enterprising folk will be remembered as the editor of a comic paper, who claimed immortality for himself for devising the term "White City" in an architectural study that appeared in *Scribner's Magazine*, and which was much more notable for announcing, for the first time, that Mr. Sullivan's Golden Gateway to his Transportation building was Roman. It is not every day that discoveries like this can be made in current architecture, though it is painful to admit that it has not received the recognition to which it is entitled among architectural experts. But then great discoverers—witness the great Christopher himself—do not always obtain their due reward in their lifetime. Then an estimable lady artist comes out in *Harper's Magazine* with a new name, more poetic, certainly, though not so catchy as the effusion of the comic historian of architecture just referred to. She thinks "Dream City" a more appropriate name for the exhibition than the prosaic practical expressive title chosen by its originators. The suggestion is a little late, unfortunately, but what might not a circulation manager have made out of an offer for a prize for the great show! This may serve as a hint for the next great American exhibition, but meanwhile we think it just as well to designate an exhibition held in honor of Columbus by a title that expresses that fact.

PROFESSOR FREDERICK'S book on architectural rendering in sepia* is an attempt to provide a handbook on a subject that naturally calls for verbal exposition and treatment. Notwithstanding this fundamental difficulty, he has produced a practical work, though perhaps at the expense of a pleasing manner of composition; it suggests, in fact, the running comments of studio or drafting-room work rather than the well-reasoned thoughts of the writer. One might also justifiably find fault with the lack of systematic arrangement in the instructions given, though it may be questioned if a more orderly method is possible in work of this kind. Apart from these drawbacks, however, which would be slight in the hands of an intelligent student, the book is capable of giving much help to the draftsman. The instructions are numerous and cover a wide range of points. Its greatest error unquestionably consists in giving students' work in illustration to students. With but one or two exceptions the drawings are manifestly the work of amateurs and as a rule are disappointing. The book would have gained considerably in value had the illustrations been from a master hand, while some thoroughly good examples of finished drawings are positively necessary in a book of this description. On the whole, it may be commended to those who cannot have the benefits of verbal training, while for those who can its shortcomings can readily be remedied.

***Architectural Rendering in Sepia*. By Frank Forrest Frederick. New York: William T. Comstock, 1892.

INDUSTRIAL CHEMISTRY.

Conducted by Dr. R. A. Witthaus.

IT is curious to note the controversies regarding the relative value of the electric light and of manufactured gas for illuminating purposes which appear in each issue of the journals devoted to these respective industries. But while such controversy is necessarily futile in itself, undoubtedly it is productive of good results on both sides, resulting in the study of shortcomings and, where possible, in the remedy of the same. In Indianapolis the other day the current from a trolley-wire went wandering and descended the hollow iron supporting pole until it made contact with a "dead" gas-main. After burning a hole in this, it continued on along the dead main until it reached a point where this crossed a main carrying gas and here burned a second hole. The gas now escaped through into the dead main, and finally, passing up the pole, was set on fire, the wires were burned, and traffic stopped. On the one hand, of course, this is proof that such a dangerous commodity as gas should not be allowed on the main thoroughfares, while on the other hand it clearly shows that the pressure of a powerful current of the electric fluid is a constant menace to human life. We do not intend to argue whether it was the match or the gunpowder which did the damage, but merely to speak of the relations of these too frequent accidents to chemistry, over that bridge between chemistry and electricity, —namely, electrolysis.

M. P. JOUSSELIN recently presented a paper before the Society of Civil Engineers of Paris in which he discusses the two primary causes of explosions from the combined effects of gas and electricity, the first being by actual contact of pipe and cable and the second by electrolytic action. From this second part of his paper we abstract the following: In Paris the gas pipes under the sidewalks are covered with calcareous earth and débris consisting mainly of carbonate and sulfate of lime; these salts are decomposed by the action of the electric current, there is an increase of temperature, and carbonic or sulfuric acid is liberated, which, being carried to the pipes, attacks them, forming carbonate or sulfate of lead as the case may be. Thus the substance of the pipes is consumed, a hole is produced, the gas escapes, and eventually an explosion occurs. The same action is observed with iron pipes, the salts of the latter metal being formed instead of the correspondin salts of lead. On June 15, 1892, a serie of these explosions occurred in two Ediso manholes at the corner of Rue Breda an Rue Nôtre Dame de Lorette. There wa much difficulty at first in arriving at satisfactory explanation of the acciden but the following was that finally adopte During the previous March there had bee snow in Paris, and salt had been used up the streets. It was concluded that th had found its way into the Edison condu and had there been electrolyzed, produci chlorin and the metal sodium. Th sodium combined with the water prese setting free its hydrogen, which in tu combined with the chlorin from the sa forming a detonating mixture which w exploded by the electric current. It is b fair to add that M. Jousselin evident does not himself accept this ingeni explanation, but considers the above e plosions to be of gas, which, having pe trated from punctured mains into the m hole, had there three times formed explosive mixture.

PIERRE GIRON has given an interesti little sketch of the Portland cement dustry of Europe, from which we take w follows. The first known cement-fact

England was built about 1825 at North-et, on the Thames. The process then ed was crude, and little or no advance s made for a number of years. In 1850 r factories only were engaged in this dustry, but since 1860 rapid progress has en made, and the present output is in e neighborhood of 8,300,000 barrels an-nually. Few improvements have been ade in the manufacture, as in England e raw materials, chalk and clay, are ob-ined in such a state of purity as to ren-er it possible to produce a high grade aterial with inferior methods. Practi-ally the entire output of the kiln goes into ne quality of cement, being graded for the market according to the fineness of grind-ng. Of late years, however, owing to the ompetition of the continent, the English ement has been sifted, but, according to M. Giron, still falls far behind the German nd French makes in point of fineness. The manufacture of cement was first in-roduced into Germany in 1852 at Stettin, and from that beginning the industry has steadily and rapidly increased until now there are 60 large Portland cement works, producing about 8,500,000 barrels annually. Having a poor material difficult to handle, the Germans have been compelled to devise and to employ the most progressive methods of manufacture, and for this purpose have organized a public association, the researches and studies of one manufacturer thus benefiting all.

In France the cement industry has advanced more slowly than in Germany or England, amounting at present to an annual output of 1,800,000 barrels. The French cement, however, particularly that manufactured at Boulogne, is of excellent quality and second to none in the world. Russia produces about 900,000 barrels of cement per year, the first works having been built in 1857. Belgium produces 800,000 barrels per year; Sweden and Norway about 505,000 barrels, of which the bulk is from Sweden; Denmark's output is 300,000 barrels per year. The rest of Europe, including Austria, Switzerland, and Italy, has a small output, which is principally what is called natural Portland cement and of no great reputation.

In connection with the above historical sketch of the Portland cement industry of Europe it may be of interest to follow its later history in this country. In 1872 Mr. D. C. Saylor began a series of experiments upon the limestones at Coplay, Pennsylvania, and was so far successful that in 1875 our first Portland cement was put upon the market. The first process, naturally imperfect, was subsequently much improved, and the manufacture is still carried on by the original company. The material used is a natural cement rock containing approximately the proper proportions of lime and clay, pure lime being added when necessary to make the requisite correction. The six works now established at this location in Lehigh county produced in 1891 250,000 barrels, or more than half of the total American output for that year. In 1874 Mr. D. Millen began experiments upon the deposits of shellmarl at South Bend, Indiana, and in 1877 a kiln was built. In 1878 this company supplied the United States government with the cement used in the construction of the Rock Island Arsenal. In 1886 Mr. Millen purchased a bed of marl and clay at Warner's, 12 miles west of Syracuse, New York, selling the works at South Bend to the present company. The Warner's plant recently passed into the hands of a Pennsylvania company and Mr. Millen again removed; this time to Wayland, Steuben County, New York, to take up the cement manufacture there, using deposits in the vicinity. A second large plant was established at Warner's by a Syracuse company. In 1891 the States producing Portland cement, named in the order of their importance, were as follows: Pennsylvania, New York, Ohio, Dakota, Indiana, Colorado, and California. The total production in 1891 was 454,813 barrels, there being 18 mills in operation, and in 1892 525,360 barrels, from 23 mills.

E. Blanc, in *Dingler's Polytechnisches Journal*, describes a process used in making hard bricks in Mongolia. It seems that in the western portion of that country the conditions of climate are so severe as to cause the rapid disintegration of ordinary bricks and even of building stone. The composition of the clay used is not given, but the process is described as follows: a vertical cylindrical kiln is surmounted by a dome, through which is an aperture for the escape of gases. There are also three chimneys inside the furnace opening outward at the height of the dome. During the first three days these chimneys are closed, the central aperture being open, but at the end of that time the fire is allowed to die down, and the dome opening is nearly closed by pieces of moist clay. The small aperture left is covered with moist felt and this with sand, which is kept wet; then the fire is again started, the chimneys being opened, and the process continued with the reversed draught for another period of four days. At the beginning of this second firing the bricks have a light red color, but gradually change to a dark gray. The finished brick is durable, hard, and sonorous, resembling trachyte in appearance. From the same journal we take a note of a new apparatus for measuring the relative hardness of metals and other substances. A beam balance carrying a diamond at one end and so arranged as to permit of carefully measuring the varied pressure exerted, together with a holder for the substance under examination, constitutes in the main the apparatus. The diamond is pointed and conical with an angle of 90°, the width of the scratch made thereby being taken as the gage of the hardness. Previous to the test the substance to be examined is polished, and the surface carefully leveled and smoothed.

AN ingenious German has invented a process for removing the element of smoke from the combustion of coal, and that by an entirely different principle from any of those suggested by others. The tests are said to have been very satisfactory, and contracts have been entered into with several large manufacturing concerns. The coal is first finely powdered by special machinery and is then injected into the furnace by an automatically regulated current of air. The carbon is entirely consumed, there is no smoke, and no ash is precipitated. The fire is under perfect control and can be started or cut off at a moment's notice. Should this process accomplish what is claimed for it, it is indeed valuable.

TAKING advantage of the peculiar properties of boracic, or boric acid, Mr. H. N. Warren has recently devised a new process, or rather an improvement over the old process, for the manufacture of borax. Common salt is subjected to the action of crude boracic acid of commerce, the decomposition aided by superheated steam being effected in large clay retorts of acid-resisting material built with tubulated tops. The retorts are charged with an intimate mixture of ground sodium chlorid and boracic acid. Connected with the neck of the retort is a condenser for the purpose of collecting the hydrochloric acid, which is disengaged in abundance as soon as the heat reaches a low red. The heat is gradually raised and steam introduced through the tubulure until at the termination of the reaction anhydrous borax remains in the retort and a dense pure acid is obtained from the condenser. Th anhydrous borax, while still red hot, i ejected into cold water and allowed to re main 48 hours, or until it has passed into solution, from which it is crystalized an made ready for the market.

IN a late issue of THE ENGINEERIN MAGAZINE we reviewed a paper by M D. R. Steuart on the "Flashpoint an Heat of Burning Oils," read before th Glasgow and Scottish Section of th Society of Chemical Industry. The Se tion at a subsequent meeting discussed M Steuart's paper, and finally appointed committee to investigate the questic fully. The following is the report, whic was unanimously adopted as the sense the Section:

> In pursuance of a resolution passed at t meeting held in Edinburgh on December 6 la your committee appointed the following su committee to investigate and report upon present legal flash-point of mineral oil :—T chairman, Mr. C. A. Fawsitt, Mr. G. Beil Mr. John S. Macarthur, Prof. Edmund J. Mi Mr. Edward C. C. Stanford, and Mr. Daniel

iart. At a meeting of committee held this the sub-committee submitted the following ort :

'our sub-committee is of opinion that :

. The present legal flash-point (*i. e.*, 73° F.) mineral burning oil is too low, and therefore, ler ordinary circumstances, dangerous.

:. The Government Abel-test is perfectly sat-ictory for determining the lowest temperature vhich inflammable vapors are evolved.

3 100° F by this test should be the minimum ;al standard.

4. The Government Abel-test is not invariably iployed to determine the flash-point, as is idenced by the fact that burning oils flashing from 73° F to 86° F. Abel-test are con-antly imported and sold, bearing brands of from :o° F. to 150° F., and thereby the public are isled.

5. All burning oil imported in this country iould have the Abel-test plainly branded on the isk.

6. Many fatal accidents have occurred from the se of this inflammable oil, and as a measure of recaution so-called "safety lamps" constructed f metal have been recommended. Unless the il itself is safe, a new source of danger is intro-luced by "safety lamps."

Your committee have unanimously adopted he above report, and have now the honor to lay t before you.

THE *Revue de Chemie Industrielle* describes the electrolytic preparation of chloroform as follows: The apparatus consists of a retort of enameled iron having a double bottom, by which means it can be steam heated. A condenser is provided for the collection of the vapors of water and chloroform which pass over. The electrodes originally were of lead, but have recently been replaced by carbon and copper; the former, the anode, consisting of carbon rods inserted upon a revolving central shaft, the whole acting as a stirrer. The cathode consists of a copper cylinder. Three hundred litres of a 20 per cent. solution of sodium chlorid are charged into the retort through a tube. About 60 kilogrammes of acetone are treated at one charge, the operation lasting two hours. The condensed distillate separates into two layers, the upper of water containing a little acetone which is saved and utilized in dissolving the salt for succeeding operations; the lower layer is of pure chloroform, containing none of the chlorinated products so common in the other processes. The yield of chloroform amounts to 190 per cent. of the weight of acetone used.

SODIUM silicate is a substance not widely known outside of manufacturing circles, and yet it finds so many important uses that a word regarding it may not be out of place. The *Oil, Paint and Drug Reporter* (New York) gives a few words on its industrial uses, and from the note there given we make this abstract. The principal use to which it is put is, of course, in the manufacture of cheap soaps, but on account of its properties it is very suitable for use either by itself or in connection with other detergent materials for cleansing articles when the action of caustic soda is too keen and the action of the carbonate not powerful enough. Several of the continental railway companies are using silicate to recover their dirty cotton waste, being able thereby to recover the same no less than 12 times, whereas by using caustic soda this can be accomplished only two or three times at the most. With the silicate the strength of the vegetable fibre is apparently not injured. The silicate has also been used very successfully as a substitute for caustic soda in the manufacture of paper, especially in the bleaching of jute and hemp waste, and in the sizing and waterproofing of paper. It is an excellent fixing agent for alumina and other mordants on cotton, and is said to be unequaled as a sizing for cotton thread in preparing stock for the loom. It has been used for some 30 years for the purpose of rendering textile fabrics incombustible. Large quantities are consumed in the manufacture of artificial stones, of enamels and paints, the so-called silicated paints containing silicate of soda as a principal ingredient. The silicate is also used in construction for rendering timber fire-proof and walls water-tight, or air-tight, for soaking bricks to prevent diffusion, for painting steam-pipes, and, mixed with asbestos, as a non-conducting material for jacketed pans, retorts, etc. It may be used alone or in connection with other materials as a cement for stone, glass, porcelain, marble, etc., and for attaching labels to metal surfaces. Certain cements owe their hardening property to the silicate of soda contained. The silicate is moreover important as the source from which pure hydrated silica is prepared.

THE presence of arsenic in glycerin destined for pharmaceutical purposes has excited considerable comment during the past year, and hence a paper by Dr. J. Lewkowitsch treating of the fact from a manufacturer's point of view is highly interesting. The arsenic in the glycerin owes its existence to the arsenic contained in the reagents used in the manufacture, and cannot be removed by distillation as has been stated. The fact of the matter is that all glycerin intended for pharmaceutical purposes is distilled and double distilled. Dr. Lewkowitsch, experimenting with the substance formed when arsenious acid is dissolved in glycerin, namely the arsenious ether of glycerol, $As\,O_3\,(C_3\,H_5,)$ found that at 250° C. it is decomposed and hydrogen arsenid with other volatile arsenious compounds is distilled over. It is quite evident therefore that any arsenic contained in glycerin will distil along with it. According to Dr. Lewkowitsch, there is no known process for freeing glycerin from its contained arsenic. The only way then to obtain the pure product is to use only such reagents in its manufacture as do not contain arsenic. This is accomplished where the fats are hydrolized by means of water, whether in the liquid state under high pressure or as superheated steam. The lime process which is still practised, especially in the smaller works, should also yield an arsenic free product, while on the other hand glycerin from works using sulfuric acid saponification will contain arsenic, unless, as is unlikely, such acid should be free from the metal. Ten samples of glycerin were examined with the object of ascertaining whether pure glycerin was on the market. Three of these samples would have to be rejected, four contained very small traces, while three only were absolutely free from arsenic. There is still another source of glycerin, the so-called soap-lye glycerin, produced in the saponification of fats on a large scale. This particular source of glycerin has however been looked upon with disfavor, though not altogether justly, as Dr. Lewkowitsch proves.

Arsenic, though the principal impurity, is not the only one to be found in "chemically pure" glycerin, organic impurity as fatty acids, etc., or as "polyglycerols," being generally if not always present. Evaporation of a sample in a platinum dish at 160° C. affords a simple test for this residue and for the ash. Fatty acids, as butyric acid, etc., and other organic impurities are readily detected by means of the ammoniacal silver nitrate test, though this is more rigorous than may be necessary.

BY means of the electric furnace described in the last issue of THE ENGINEERING MAGAZINE, M. Moissan has obtained some interesting results in the reductio to the metal of some of the most refractor oxids. Uranium was obtained by subject ing a mixture of uranic oxid, $U\,O_3$, and o the green oxid, $U_3\,O$, with a little powdere charcoal to a current of 450 amperes at 6 volts. An ingot of metal was produce consisting of about 90 per cent. uraniu and 10 per cent. carbon. This carbi slowly decomposes water at ordinary ten peratures and has a melting point muc higher than that of platinum.

By exposing a mixture of pure protox of manganese and carbon to 300 amper at 60 volts, in 5 or 6 minutes an ing of manganese carbid weighing 100–1 grammes is obtained. The carbid th produced contains 89 per cent. of metal manganese, but by using an excess of t oxid the percentage of carbon is reduc and the metallic manganese increased 95 per cent. A mixture of sesquioxid chromium and carbon is reduced in t same manner, a metallic ingot adherent the crucible and containing about 89 cent. of the metal being obtained. Natu chromium can be reduced as the oxid, by repeated treatment a practically p chromium produced.

MINING AND METALLURGY.

Conducted by Albert Williams, Jr.

is not the function of this Department to expose individual mining frauds, or interfere between dissatisfied sharelders and the "control" (that is, the icers and the "inside" owners) of mining mpanies. If the broad principles of chnical mining and of mining financierg are presented, however imperfectly, at is about all that can be expected in ch a publication as THE ENGINEERING AGAZINE. But frequently letters are reived asking for information and advice to particular instances. These are nswered by letter so far as our knowledge ermits, but cannot be discussed in these olumns, for want of space,—to say nothing f want of interest to most readers. Still it nay be well to offer, once for all, some general suggestions in regard to cases of he kind; and as an exception, and also by way of text, the following extracts are quoted from a sample letter out of the many lately received:

> . . . Being a regular subscriber to THE ENGINEERING MAGAZINE, I take the liberty of writing you for information. There are quite a number of citizens of ——— and myself, who have been led into a mining enterprise, and the more I can find out about it the more it looks like a "fake" or an intended squeeze-out. What I want to know is what is the proper course to pursue in order to bring the officers of a mining company to proper terms. If the company should turn out to be a pure "fake," is there no lawful means of redress? If money can bring the [expletives] to justice and do legitimate mining a good turn, then we can easily and gladly furnish what is required. The company made great claims, and no doubt false ones, in their communications with stockholders. The mine is the ——— of ———, office in ———. Now, they may be all right; but from present information all is wrong. What course would you recommend the stockholders in the East and in ——— to pursue? . . .

In the present instance we have no personal knowledge either as to the merits of the property or the character of the management, only having noticed that there are some ugly rumors afloat. Not knowing anything positive as to the right or wrong of the controversy between the dissatisfied shareholders and officers, the advice given is: First, ascertain definitely whether there are reasonable grounds for complaint. Hear both sides. Get the commercial rating of the men accused. Find out what the local opinion is in the district where the mine is located. If the opposition seems to have a good case and the trouble continues, the dissatisfied shareholders should put themselves in communication with each other, with a view to concerted action. This can be done by advertisement or correspondence in a prominent mining paper, calling a meeting to exchange opinions, ascertain facts, estimate strength, and decide what, if any, steps should be taken. If the opposition finds that it holds a controlling interest in the stock, remedial measures might be taken without going to law, by deposing the incumbent officers and assuming the management and responsibility of the company's affairs. The courts have ruled that shareholders have a right to examine the books of corporations. It has also been held that shareholders may enter and examine to their own satisfaction a mine they are part owners in. Whether they may send in a professional expert, not himself interested, is debatable. But a representative committee of shareholders could be authorized to make both examinations (of books and mine). A case having been made out, the property having been shown to be worth fighting for, so that it would not be throwing good money after bad, prosecution under the civil code would be next in order, provided the dissatisfied shareholders were willing and able to go to the expense and delays of somewhat dubious litigation.

Much depends upon the laws under which the company has been incorporated, which are often not those of the State in which the mine is situated. These laws vary greatly in respect to the amount of protection afforded to shareholders. For example, in some States assessment notices have to be served personally and the delinquent sales made within the State, on further service of notice. In other States the charter laws are so lax that a man does not know whether he owns his stock or not (legally speaking), and if it stands in the name of a trustee he has to get it transferred before he can vote it. It requires experienced mining lawyers to unravel the mysteries of mining and corporate laws. At the bottom, the laws and the courts mean well enough; but it is expensive to reach the bottom. Suits in equity are especially uncertain.

To be perfectly frank, here is the moral: Small investors in mining schemes, who accept the representations of prospectuses and advertisements as gospel, who expect to become millionaires at a jump by puting in a few dollars or hundreds, who do not take the precaution of finding out *beforehand* what they are going into, do not deserve much sympathy. Many of them would buy "green goods" if properly approached. The heavy investors generally have the advantage of impartial expert advice, and can at all events protect themselves in a measure. The little minnows have small chance, and it is to catch them, not the big fish, that fraudulent mining schemes are put forth.

THE relatively depressed condition of silver-mining has deflected the attention of investors toward mining for gold, and just now gold-producing properties are in especial favor with European capitalists. The English investments in the Transvaal gold-fields have been largely increased during the past year, while French syndicates have acquired important holdings in American gold-mines and are considering others. A similar feeling has prevailed among Eastern capitalists in this country, so that it has been much easier to raise capital for the prosecution of gold-mining than for some time past. The demand for this class of properties has been stimulated rather than satisfied by the creditable showing of some of the recently-opened districts in the Rocky Mountain region. Miners, too, are turning their attention in the same direction, and several incipient "rushes" to new gold-fields, brought about by slight evidences of value, have been the result. The shutting down of a number of large silver-mines and the lessened activity in others, by throwing many men out of employment, are adding to the army of prospectors, most of whom will give their special attention to the search for gold. The older steady-going gold-quartz districts keep on the even tenor of their way, with about the same, or perhaps a slightly increased, output, while a considerable addition to the gold production will be made from those hydraulic mines in California, so long closed by the débris legislation, where resumption of work will be permitted under the new system. In short, everything points to an improved position of the gold-mining industry of the United States.

IN a series of letters to the *Iron Trade Review* (Cleveland) Richard A. Parker presents some strong arguments and figures in support of a proposition long studied and advocated by him,—the establishment of a great iron-smelting and iron- and steel-manufacturing industry on Lake Superior, with especial reference to Marquette as a center. Mr. Parker's plan is to bring Connellsville (or possibly New river) coal to the seat of the iron-ore producing districts, and to coke it on the spot, as has been done at West Superior and Duluth. The yield of coke per ton of coal is somewhat less on the lake than in the coal and coke region of Pennsylvania, being 62 to 64 per cent. as against 65 or 6 per cent., or perhaps a difference of 3 to per cent., owing to deterioration of the coal; but it is agreed that this loss, sligh on account of the dryness of the climate is more than offset by advantages of loca coke-making at the iron works. Mr. Parke calls attention to the economies gained b the waste heat (not necessarily the wast

s) of the coke ovens for steam-making the utilization of by-products, and its to European practice and American eriment in proof. He argues that, if d coke can be made at the lake for o per ton (the detailed estimates foot-up less than $5), with cheap, pure, and ed ores at hand, flux near by, and a ing plant operated in connection with nace and mill, the outlook is very prom-g. According to Mr. Parker's calcula-ns, which appear to be conservative (and a later communication to this depart-nt he states that his anxiety to be on the e side has led him to adopt figures rather o high), coke iron ought to be made at arquette cheaper than at Chicago by a ference of about $1.45 per ton. So much r the question of assembling the material d cost of manufacture. The next point, ter the vital one, as Mr. Birkinbine ointed out in his admirably judicial paper n "Locations for the Pig-Iron Industry" the March number of this Magazine, is hat of transportation, freight rates, and arket. Into this phase of the matter Mr. Parker enters with an array of statis-ics, which he considers show convincingly hat the growing consumption of iron pro-ducts in the Northwest demands a supply enter on the Lake, say at Marquette. It is impossible to fairly present Mr. Parker's argument in a condensed shape, but it is well worth consideration, in its original form of publication, by furnace-men and the iron trade, and has attracted wide attention, with some opposition, but generally favorable comment by the technical press.

It is often important that the grade of adits and main levels should be conformed as nearly as possible to theoretical perfection. This is especially true in two cases: (1) where great quantities are to be handled, as in coal mines and in some kinds of metal mines, and (2) in very long adits. In the first instance it is a question of economy in haulage; in the latter, a question of saving all the grade possible, in order that the heading may be at the greatest available depth, and it is evident that the inches of rise per hundred feet count up fast when the adit is to be a mile or perhaps four or five miles long. In determining the most advantageous grade, another consideration has to be taken into account,—that of drainage. As to haulage that grade is theoretically best on which equal power is required to move the loaded cars down hill and the empties up hill; and in practice, since the track can never be kept perfectly true, it is customary to favor the loaded cars. In André's Mine Engineering the rule given is 1:111; but for ordinary short-distance work it is common to choose a grade of 1:100, and sometimes steeper, which may answer well enough for small mines.

Mr. Richard Lewis, of Carbonado, Washington, has lately reopened the subject, and has recorded some new experiments with real mine cars on actual grades, a method more satisfactory than mathematical discussion where the factors are so irregular. He finds that, with good track and well-oiled mine cars, lighter grades can be adopted than those usual, and recommends 0.42 per cent., which is 5 inches per 100 feet or ⅛ inch per 10 feet. Even this leaves a margin above the calculated grade of equal resistance (0.32:100 or 1:314) for cars of the weight and at the speed taken in the experiments, allowing for ill-conditioned road, stiff cars, and lower speeds. As to drainage, it depends very much upon the smoothness and regularity of the channel. A boarded drain, laid true, if of sufficient size, will carry all the water a mine will make, on the grade recommended by Mr. Lewis; while, as is well known from experience with unlined ditches in hydraulic mining, it is quite possible to kill a grade several times steeper by breaking it up into jogs.

When the Chicago Exposition was opened at the beginning of last month, the mining department was found to be especially backward and incomplete. The building itself had been finished eight months previously, and had long been ready for the installation of exhibits. The blame for the unsatisfactory state of progress is ascribed to the want of punctuality on the part of exhibitors in forwarding their collections; and it was remarked that the nearby American States were more dilatory than foreign exhibitors at great distances, which seems to indicate poor management on the part of local organizations and lack of initiative in the general management. It is expected that by the time this number of the ENGINEERING MAGAZINE reaches its readers the mineral exhibit will be in presentable shape.

SPEAKING of hydraulic ditches and their grades recalls to mind a remarkable, if not wholly original, method of laying out a ditch line of this kind by an ultra practical man who scorned leveling instruments. He had no use for levels and rods and pegs, or even the makeshift implements of the miner; so he began at the proposed upper end of the line and scraped a slight trace in the ground where the water would first follow him down, insisting, to the amusement of the bystanders who were watching the proceedings, that this was the natural and safest way of establishing a grade. Now, the reason why a small drain underground in a mine will not always carry water on low theoretical grades, but leaves the floor of a drift or tunnel spotted with bogs and puddles, is the same that was discovered by our amateur ditch surveyor, who found himself consuming the fall at an alarming rate and running out a grade which, on the scale of a full-sized ditch, would create a young torrent and at the same time come out about the level of the natural mountain stream tapped and far below where the water was wanted. These small unlined channels in natural soil and rock cannot be made and kept true; the frequent jogs kill the grade, and the irregularities of the sides and bottoms defy formulæ for friction and negosity.

THE by-products of iron-manufacture formed the subject of a recent lecture by Mr. Thomas Turner, who described the various methods of utilizing waste gases, etc. At some of the works tar is extracted from the gas when hot, and ammonia when being scrubbed, and what remains serves to fire the boilers. The furnacemen, therefore, instead of being the enemy of the agriculturists, as formerly, interfere but slightly with the purity of the air, and supply valuable manures, disinfectants, etc. Basic slags are also now being used for road metal, and bricks, cement, etc., are made of it. Large quantities are also used in the work of reclaiming land. Besides this, the production of slag wool gives a valuable article for packing purposes. Tap cinder is now found to produce a cast iron not of special purity, but suitable for many purposes, and the hot air from the puddling furnaces is frequently used to fire a boiler instead of being wasted as formerly. In the Bessemer process phosphate of lime is extracted, and found to be a valuable recuperative fertilizer.

MR. E. O. LEECH, the Director of the Mint, has prepared a report on the production of the precious metals, covering the calendar year 1892. The value of the gold product from the mines of the United States was approximately $33,000,000, about corresponding to the average product of recent years, being slightly les than the product in 1891 and somewha larger than the product of the two prio years. The product of silver from our ow mines is placed at 58,000,000 ounces, of th commercial value, at the average price o silver during the year, of $50,750,000 and c the coining value, in silver dollars, of $74 989,900. This is a falling off of 330,00 ounces from the product of the precedin year. The Director reports that there wa a diminished silver product in each pro ducing State and territory of the Unite States, except in Montana and Colorad the two large silver-producing sections.

JUDGE BISSELL, of the superior court, i Colorado, has made a ruling in the matt of expert testimony in trials, which wi have a deterrent effect upon the prese system of employing *ex parte* expert test mony in mining title cases. The decisi was made in the case of a physician's a count for $25 a day for testimony in murder case, but it will serve as a prec dent in the case of mining engineers a other experts as well. Judge Bissell hol that, even if the lower court should ord a greater allowance, the regular fee o a day is all that experts can get, and, hese witnesses are to have more, the slature will have to take action first.

HE old Chile roller mill has been mod- ized and much improved in mechanical ails, retaining the same principle but reasing the capacity and being under ter control. The new form is known as Bryan mill. It is made in San Fran- co and is being extensively introduced o Mexico. For convenience of trans- rtation in the mountains it is built in ctions. It is said to be a good amalga- ator and cheap to transport and erect. ne primitive arastra, the starting point d prototype of the Chile mill, the grind- g-pan, and all similar machines, does cellent work in a slow way; and several rms of its later and more highly devel- ped progeny are still among our most seful machines, though their sphere is mited as compared with that of stamps.

AT Anniston, Ala., may be seen a note- orthy system of rapidly mining soft iron re on a very large scale by means of steam hovels. In places the working-face of the leposit has been cut so deep as to preclude he use of the shovel, but it is the purpose of the Woodstock company to mine the whole hill clear of everything down to the level of the present cut, taking all clay and rocks heretofore left in the banks. A large ore-washing plant handles the product.

THE great number of new chemical and metallurgical processes which are constantly being introduced, the commercial success of which must depend almost wholly upon the supply of large amounts of motive power at low cost, seem to indicate that the new city growing up at Niagara Falls may become not only the seat of many large manufacturing plants of types already familiar, but also of important new industries as yet unthought of.

THE production of pyrites in the United States has increased from 13,440 tons in 1882 (the first year for which statistics are quoted) to upwards of 100,000 tons annually. These figures refer only to the amount mined for making sulphuric acid. There are, besides, very large quantities mined and concentrated in the Far West as gold and silver ores, and in their treatment the sulphur contained is generally regarded as merely a nuisance to be gotten rid of, as is done by preliminary roasting before feeding into the lead-smelting furnaces. A new iron matte-smelting process utilizes raw pyrites, and chlorination disposes of them also; but all the time there is a valuable element going to waste. It is true that the pyrites mined in the West does not make a good commercial acid as a rule, on account of impurities such as arsenic. But it looks as though there should be some way of treating the sulphuret concentrates obtained from gold mills, and the occasional massive pyrite ores which would not need concentration, by a process that would economically yield, as a by-product only, sulphuric acid good enough for certain metallurgical and other uses where a cheap acid is needed. The residues, as now, would be in demand as flux, and the precious-metal contents recovered in the usual manner.

THE latest report of the Texas Geological Survey gives an interesting and conservative account of the lignite deposits of that State so far as explored, and throws light on questions brought up by investments in those fields. Not much mining has yet been done, but, so far as it goes and so far as trial borings have been made, the beds seem to be unusually regular and reliable, while the quality of the coal is good, considered as a lignite. Mining should be very cheap, as the beds are so near the surface and so free from water. As in other cases in the Western lignite areas, the utilization of these resources will increase with the local demand as population increases.

SOME doubt is expressed as to the reliability of the experiments of Dr. Seger, the German ceramic technologist, which appear to show that quartz is appreciably volatile under conditions of not extraordinary temperature, as in the Deville furnace. The reported results are quite startling. If confirmed by further research, they may possibly offer a clue to certain phenomena in the smelting of metals in which silicon plays a part, and thus lead to modifications in the metallurgy of iron, aluminum, and other metals. It should be a very simple matter to repeat the experiments under precautions, and thus settle any uncertainty as to the main question. There is no inherent impossibility about it, or any greater improbability than in plenty of other recent discoveries of the same order.

ACCORDING to Mr. John Fulton, who has been contributing an admirable series of papers on coke and coke-making to the *Colliery Engineer* (Scranton), there are four prime characteristics to be considered in judging of the value of coke for use in the iron blast-furnace. These are: (1) hardness, to support the burden of the furnace; (2) full development of cell-structure, so as to expose the largest surface to the blast and insure rapid combustion and high heat; (3) purity, for obvious reasons connected with the quality of the product and the avoidance of too much inert matter to be slagged off; and (4) uniformity in quality. While the requirements for iron-smelting are very exacting, in lead-smelting (by which the greater part of the silver is now obtained), coke of much less strength, less calorific power, and less purity can be successfully utilized. Of course the lead smelters prefer a good coke; but it is fortunate that they can manage with what would be rated as inferior qualities in the iron-making districts, and thus utilize a cheaper and nearer fuel than would otherwise be available.

MONTANA'S silver statue of Justice, for the Columbian Exposition, was successfully cast at the works of the Chicago Bronze Co., and is now on exhibition. It is of life size, and is believed to be the largest silver casting ever made. The metal used, 1600 pounds, is all from the ores of Montana mines. Aspen, Colorado, also has erected a "silver queen" as a part of its exhibi in which over $20,000 worth of silver, gol and ore were used.

THE electric furnace has been applie by M. Moissan in the reduction of uraniu from its ores. Using it at a temperatur of 3000° C., a 250-gram ingot has bee made in ten minutes.

RUTHENIUM is one of the rarer metal and has hitherto been quoted in New Yor at $5.50 per gram. M. Troost, the emine French chemist, has recently obtained a ingot weighing 20 kilos., the largest qua tity yet made. The method of separatio and reduction is not stated, but the sourc was crude platinum sand.

FOR about a year efforts have been mad to open a market in Europe for anthraci coal. The European agent of the Phil delphia & Reading Coal and Iron Co. h reported that the trial shipments sent points in Germany and Italy have made favorable impression, although it was foun necessary to also ship stoves designed burn hard coal before the experiment cou be begun. It seems reasonable to expe that a considerable demand might be c ated there for domestic use, when t character of the coal becomes better u derstood. Freight rates would probab not be prohibitory in many continen markets.

AMERICAN capitalists have bought phaltum deposits in the State of Tamau pas, Mexico. Valuable discoveries of bi minous minerals and oil are reported have been made in southern Mexico.

THERE was a marked decrease in production of pig iron and steel in Gr Britain in 1892, as compared with 1891 1890. The make of pig iron was 6,616 long tons, against 7,228,496 tons in and 7,875,130 tons in 1890; while the s output has declined proportionally.

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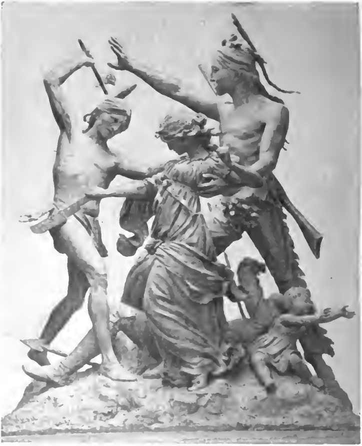

THE MASSACRE AT OLD FORT DEARBORN.

BY CARL ROHL-SMITH, ON AN ORDER FROM MR. PULLMAN, FOR A PARK IN CHICAGO.

[Described in the Department of "Comment and Criticism."

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THE FINANCIAL SITUATION.

By Matthew Marshall,

Financial Reviewer of the "New York Sun."

IN the slang of Wall street the financial condition of the country is described by saying that "money is tight." There is plenty of it to be had, indeed, on call and on readily marketable collaterals, but, when it is wanted for any length of time and upon securities that cannot easily be sold, the case is quite different. When, as people say, "money is tight," it is not the money, but the owners of it who are thus described. Lenders have for the moment lost faith in the ability of their would-be debtors to pay their debts, and look with distrust and suspicion upon applications which previously they would have favorably entertained. The change in their feelings is part and parcel of the collapse in the New York stock market which has brought ruin upon so many adventurous speculators. Just as the public has passed from a state of mind in which it was ready to pay without hesitation the highest prices for fancy stocks, regardless of their intrinsic value, to one in which it will not buy them at any price whatever, so it has passed from a readiness to lend to anybody and everybody, on any kind of security offered, to one in which it will scarcely lend at all. Secretary Foster's silly bond negotiations last winter aroused fears in the public mind which have been intensified by the mysterious and vacillating policy of his Democratic successor ; public confidence has been shaken ; and, in their ignorance of the precise danger to which they were exposed, the great money-lenders have followed the course dictated by prudence, and, in order to diminish

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their own liabilities, have contracted their accommodations to borrowers. This has set in motion a process of liquidation, in the course of which, as in every struggle for existence, the weaker participants have gone under.

Since the beginning of February, when speculation in stocks was at its height, and confidence in everything and everybody was unbounded, up to the last of May the banks of New York lost in deposits $58,750,900, but in coin and paper money only $8,901,800. During the same interval they reduced their loans to borrowers $49,008,600, or $40,106,800 more than they lost in cash. This curtailing of loans by the banks here, large as it is, is but a part of a larger total to which borrowers all over the country have had to submit. Both financial institutions and individual lenders, in other places as well as in New York, have restricted their loans, and the consequence has become visible in the many failures which have been reported, both of corporations and of private persons. These failures are attributed to "tight money," but the real cause is a withdrawal of credit. The concerns which have become bankrupt were large borrowers, and had invested their borrowings in assets which were either valueless, or at least unmarketable. They were in the same situation as were the stock speculators who came to grief at the beginning of May. They had bought what they could not pay for, and suffered accordingly.

If Congress were in session, the prevailing difficulty of borrowing money would almost certainly lead to the introduction of measures for relieving it by increasing the supply of currency, and there would be plenty of eloquent speeches made in their behalf. But that the financial stringency is not due to any lack of circulating medium is proved by the fact that during the last four months $15,000,000 of additional Treasury notes have been issued for purchases of silver, under the Sherman act, and have gone into active circulation, while the gold that has been exported to Europe has been drawn mainly from the vaults of the Treasury, and not from people's pockets nor from the banks. On the other hand, that the stringency proceeds from the timidity of money lenders is demonstrated by the reduction of the volume of bank loans, as well as of those of individuals.

We are not alone in our misfortunes. The rest of the world is not only in a worse condition than we are, but it has been so for a much longer time. The Baring collapse in London, three years ago last autumn, benumbed, as it were, the whole continent of

Europe, and its effects are still far from having disappeared. The Argentine Republic, in which the Barings sunk so many millions of pounds of their own money and that of their too credulous countrymen, is to-day no better off than when its bankruptcy brought down the Barings. There is even good reason for fearing that the entire mass of Argentine securities held by the Bank of England against the £4,400,000 of Baring obligations which it joined with the other great London banks in guaranteeing will prove insufficient for the purpose, and that the associated guarantors will have to make good a large deficiency. The recent numerous failures of Australian banks are the outcome of a revulsion which began in the summer of 1890, and against which a struggle, proved by the event to have been unavailing, has ever since been kept up. Looking back from our present point of view over the course of events, it is rather surprising that we should not have taken warning from them and prepared ourselves for what has ultimately happened; but even in these days of steamers, telegraphs, and newspapers most people are so occupied with their own affairs that they pay little attention to what is going on in remote points, and only awake to a consciousness of disasters abroad when they feel their effects at home.

FINANCIAL depressions like the present are, as we all know, not infrequent, and, while each one of them has its peculiar characteristics, there are many features common to them all. They are preceded by seasons of great activity and apparent prosperity, and are followed by periods of comparative stagnation, out of which emerges another season of activity, to be followed in turn by another depression, and so on, over and over again. Evidently they have one general cause, and the attempts which are often made to account for them by reference to special agencies, and to devise special means for their prevention, are based upon a partial understanding of their nature. Thus, the advocates of free trade ascribe them to protection, and say that they would disappear if all protective duties were abolished. Free silver men assert that they result from making gold the single standard, and the speech of Senator Jones before the Brussels Monetary Conference elaborates at length this evil consequence of the demonetization of silver. Soft money men of the old greenback school say that an abundance of paper money is a sure safeguard against them, while orthodox gold monometallists see in our present evil plight only the workings of the Sherman act. Allowing its full value to each one of these factors still leaves it unexplained why the alternations of buoyancy and depression which they are supposed to produce happen as well under free trade as under protection, in silver-using as well as in gold-using countries, under the reign of metallic money as well as under that of paper, and in places where there is no Sherman act as well as in that where there is.

A more complete and philosophical solution of the problem is found, it seems to me, in the constitution of human nature itself, which bears with impatience the dullness of a monotonous level, and rapidly passes from one extreme to another. Enthusiasm and despondency are equally epidemic. When prices are rising and profits, even though they are only on paper, roll up rapidly, everybody, as we have lately seen, is eager to buy; but when, after this eagerness has evaporated and suspicion succeeds to confidence, the current turns the other way, everybody desires to sell, prices fall, and, until the remembrance of the losses thus incurred is obliterated by time, nobody is willing to make fresh ventures. This is what has just happened on our Stock Exchange. On a larger scale and in varied forms it occurs from time to time in every kind of business, and, when it occurs in all kinds and in many countries at once, it produces a world-wide depression such as we witness.

Take as an illustration the way in which the British money-lenders have behaved with regard to the Argentine Republic. Here is a country remote from the centers of civilization, embracing vast areas of land of which only a hundredth part is cultivated, and containing a population of not much over 4,000,000, a part of whom are Indians. Into this thinly settled wilderness British capital, from 1885 to 1890, was poured to the extent of $750,000,000 or $1,000,000,000. In return for it were received bonds of the republic and bonds of the individual provinces composing it, shares in banks, railroad companies, and water works companies, and an immense amount of obligations called *cedulas*, which were paper notes used as money and secured by mortgages upon land at the inflated valuation which the speculative fever produced. The upshot of the whole affair is that the country is now burdened with a public debt in various forms of $500,000,000, besides the debts of individuals and of private corporations, and has outstanding a paper currency of $300,000,000, depreciated to one-fourth or less of its face value. For 4,000,000 people, partly savages, this is a crushing burden, and their bankruptcy is not surprising. The present state of things ought to have been foreseen by any reasonable mind, and, indeed, it was foreseen and predicted by many, but the British public, led by the Barings, would not be stayed in their mad career, and insisted on throwing away their money. That a revulsion followed in due time, and that a prolonged depression in Argentine securities should succeed to the avidity with which they were at first bought, was inevitable.

The depression in Australia is likewise a reaction from a senseless and excessive confidence in the wealth-producing capacity of a young and undeveloped country. The five colonies of Australia proper, namely, New South Wales, Victoria, Queensland, South Australia, and Western Australia, have in the aggregate a population of only about 3,000,000, and yet they have contrived to get credit in Great Britain, in one way or another, for nearly £150,000,000, or $750,000,000. In addition, it is estimated that the Australian banks have taken from British depositors on certificates of deposit bearing interest about £100,000,000, or $500,000,000, which, as fast as they received it, they proceeded to lend to speculators in real estate, while the money borrowed by the colonies and municipalities was lavishly expended upon railways, telegraphs, and public buildings and works. The flood of money thus suddenly let loose upon them set the Australians crazy. Real estate rose to fabulous prices, and the workmen in various trades, not content with the enormous wages they were getting, struck in 1890 for the exclusion of all competitors. This pricked the bubble, and ever since, as I said, the colonies have been struggling to avert a collapse which has just come. From a condition in which they enjoyed unlimited credit and could get all the capital they desired merely by asking for it, they have passed into one where they cannot even obtain a delay in the enforcement of claims against them for previous borrowings.

It is to be observed that in Argentina there has never been any lack of paper money, and that in Australia the gold standard has been rigidly maintained. We have had similar experiences in this country, each one under different conditions of coinage and currency, but each also following the same general course. The revulsion of 1837 took place under the reign of silver, that of 1857 during a prevalence of the gold standard, and that of 1873 when we had nothing but depreciated paper. Since then we have had several little collapses, like that which we are now witnessing, in which the currency is only an incident, and not the principal cause.

THE encouraging features of the financial situation are the activity manifested in the work of clearing away the wrecks of the various firms and corporations which have been forced into insolvency, and the good prospect discernible of their soon being able so to readjust their debts that they can resume the management of their own affairs. This cheerful coöperation of debtors and creditors in readjusting the burden of debts to meet the necessities of circumstances is a characteristic of modern civilized commerce, and especially of the commerce of this country. The debtor is no longer, as he used to be, the slave of his creditors; he cannot now even be imprisoned for failing to pay his debts, as he could both in Europe and in this country until not many years ago; he is viewed as being, in a sense, the partner of his creditors, and therefore entitled to divide with them the losses incurred through his want of skill or want of luck. Besides, it is seen that, as a live dog is better than a dead lion, so a customer in active business, with even moderate means, is of more benefit to trade than an idler whose hands are fettered by obligations which he cannot discharge, and who is a dead weight when he might be an active force.

Under ordinary conditions the prompt readjustment of debts after a collapse of credit such as we are now experiencing would produce a more hopeful feeling and restore business to its normal course. Debtors having made settlements with their creditors to the mutual advantage of both, confidence would at once succeed to alarm and distrust. It was thus that the panic of 1857 passed away, and that of 1860, complicated as it was by the war of secession, disappeared as soon as the nation saw the full extent of the task that lay before it and set earnestly to work to accomplish it. The troubles of 1873 lasted longer, but they, too, ultimately yielded to the efforts of enterprise and industry. Those of 1884 were of short duration, and so were those of 1890, though perhaps some of their consequences were never fully removed, and now remain to plague us. According to all precedent, therefore, we ought speedily to recover from the prevailing depression.

What renders it impossible to predict with confidence the usual happy result in the present instance is the uncertainty that hangs about the policy of the national administration and the legislation of Congress. The repeal of the Sherman act is viewed, in this part of the country, as the one thing alone needful to remove all cause of apprehension and permit business to revive. Whether the act has produced all the mischief that is attributed to it, and whether it has not also, by averting other mischiefs, deserved a credit which it has not got, may be disputed ; but its workings hereabouts certainly inspire alarm and unsettle confidence. When the administration came into power, we were assured on all sides that the act would be repealed as soon as Congress could be got together, if it took all President Cleveland's influence and patronage to do it. Then we heard that a canvass was making of the new House of Representatives to ascertain the sentiments of its members in regard to repealing the act. Then an ominous suppression of the result of this canvass led to the unpleasant suspicion that it showed a majority of representatives against the repeal. Now we are informed that he is waiting for events to strengthen public opinion in favor of the repeal, and thus to compel a majority of members of Congress to vote for it.

It is the same thing with regard to the maintenance of gold payments by the Treasury. To this maintenance President Cleveland is committed, personally, by numerous utterances made both before and after his inauguration ; and public opinion, in this city at least, would sustain him in the exercise of even doubtful powers in preserving it. But his course on the subject has been perplexing, not to say vacillating. His secretary of the treasury, it is notorious, was ready to suspend the payment of gold on the Treasury notes of 1890, and had substantially, if not formally, issued an order to that effect. The president has the credit of countermanding the order, but no one who knows him will believe that it was issued without previously consulting him. Again, it was at first confidently asserted that bonds would be sold for gold to replenish the gold reserve as soon as it fell below $100,000,000, and figures were daily promulgated from the Treasury Department showing that the reason why bonds were not issued was that the $100,000,000 was still intact. At the same time an appeal was made to the banks throughout the country to come forward with their gold and make the issue of bonds unnecessary. Now the talk is that the reserve will be allowed to fall even to $50,000,000 before bonds are issued, and it is not asserted confidently that they will be issued then.

A similar uncertainty prevails in regard to the repeal of the prohibitory tax on State-bank circulation. The platform upon which President Cleveland was elected demands the adoption of this measure. It cannot succeed without his assent, and his opposition would probably kill it ; but whether he favors it or is hostile to it has not yet been made known. The revision of the tariff, also, to which the party in power is pledged, is another disturbing financial factor, the full effect of which cannot be estimated until the extent and character of the revision are announced.

The mere announcement by the president that he intends to call Congress together in September and recommend it to repeat the Sherman act has had a reassuring effect upon the public. It has quieted alarm and inspired cheerfulness, and, coming as it did after the first spasm of depression had spent its force, it has stimulated the usual reaction from despair to hope.

For anything like the speedy establishment on a stable basis of our financial system there does not seem to me to be much reason to hope. The delusion that an abundance of currency means an abundant supply of money to every one who wants it is still far too prevalent to permit of the putting upon paper issues of the restrictions which sound principle dictates. The fundamental principles of finance, that an increase of the volume of currency reduces its value, and that currency of less value tends to drive out that of greater value, will have to be much more widely taught and accepted than they are at present before our legislators will act upon them. They must do what their constituents demand, and the demand is now, as it was during the prevalence of the greenback craze, for an abundant supply of circulating medium regardless of consequences.

Fortunately, the country is rich enough and strong enough to endure without irreparable injury the severe but effectual process of learning wisdom by experience. In fact, our very success in resisting and overcoming the mischievous tendencies of bad financial and economical legislation delays our progress toward a true system. As a strong, healthy young man can for years defy the laws of health and the warnings of his physicians, and in his eating, drinking, and course of life can do with impunity many things which, according to precedent, ought to kill him, so we have been going on in financial matters disregarding the experience of other nations without as yet incurring the natural penalty of our sins. But this immunity cannot be expected to last forever. Sooner or later the laws of finance, like those of health, will vindicate themselves, and our people are intelligent enough, it may be presumed, to learn from results, at least, what they cannot be taught by warning and prophecy.—*The New York Sun.*

LIMITS OF THE NATURAL-GAS SUPPLY.

By S. S. Gorby,

State Geologist of Indiana.

MATTER is known to occur in three forms,—solid, fluid, and gaseous. Gas is matter in the most extreme state of tenuity known to man. Of the various kinds of gas, some are heavier and some lighter than air. By nature's processes matter is changed from the solid to the fluid or gaseous state, and *vice versa*. The process of changing matter from the solid to a gaseous state is one of decomposition. The change from a gaseous to a solid condition is the result of a combination of elements. All gases with which men are familiar, excepting, of course, common air, are the result of the decomposition of solid or fluid matter. In a commercial sense there are two kinds of gas, natural and artificial. Artificial gas is that produced by methods in which the decomposition of matter is hastened by the artifices of man. Natural gas is that in which the accident of position has led to its production by the decomposition of matter in obedience to natural laws. The substances from which gas is derived are the same in both instances. Technically speaking, all gas is natural gas. With reference to artificial gas, man's knowledge of nature's processes enables him to place the gas producing material in such a position as to hasten decomposition, and he applies the husbanded product to his own use. By artificial means the process of gas generation is hastened, but the product derived is the result of the operation of the same laws that operated in producing the stored gas of the widely known fields of Indiana, Ohio, and Pennsylvania.

With reference to the substance commercially spoken of as natural gas, and understanding that it is a product of decomposed matter, the next thing is to determine the kind of matter from which it is derived. Matter is of two kinds, organic and inorganic. The natural gas of commerce is confined in various kinds of rocks, which are inorganic. The presumption is that this gas originated in the rocks that confine it. If the gas originated in the rocks that now confine it, it must be the result of chemical changes that have taken place in the rocks themselves since their deposition. Without geological evidence the presumption would be strong that the gas is of inorganic origin, as some maintain; but geological investigations have disclosed that the rocks that form the various gas reservoirs contained, at a very remote period, vast quantities of organic matter, both animal and vegetable. This organic matter was deposited with the sediment in ancient sea bottoms, just as vast quantities of organic matter are being deposited to day in the mud at the bottom of our existing seas. It is well known that, when organic bodies, either animal or vegetable, are deposited upon land, or in shallow waters, or are buried slightly beneath the land surface, decomposition immediately begins. The combination of elements is broken up, and complete dissolution of the body is the final result. The gases that are generated escape into the atmosphere, and these, as a rule being lighter than common air, are lifted by the heavier body to an altitude where the tenuity of the air equals that of the gas, where, it is reasonable to assume, a complete separation of the elements that form the gas occurs, and the separated atoms of matter fall back to earth to enter into new combinations. But when a body is deposited in deeper waters, the air is excluded, and it may remain for a long period before chemical changes occur in the tissues. It is soon covered with the silt of the sea. This fine mud, impervious to air, continues to accumulate, as other organic bodies are deposited, and the process of decomposition may be arrested, or measurably retarded, for ages. The accumulations of silt and other matter continue to increase, until finally there is a sufficient weight of superincumbent matter to wholly confine the gas that may be generated.

To illustrate: There is a vast body of water just north of the equator in the Atlantic ocean, known as the Sargasso sea. This is in a region of comparative calm so far as winds and oceanic currents are concerned. This vast space, hundreds of miles in extent, is full of great masses of floating seaweed. It is not uncommon to find solid masses of these marine algæ covering areas of seven or eight hundred square miles. Some species of these seaweeds are of gigantic size. They grow at the surface of the water and are continually sinking to the bottom of the sea, where they are mixed with the silt and more or less animal matter. When the deposition of this organic matter ceases, the accumulations of silt will steadily increase until the whole mass of vegetable matter is buried hundreds of feet in oceanic mud. Later on chemical changes will occur in the silt, itself, as well as in the buried mass of vegetation. The mud will become indurated, and finally hardened into shales, or other forms of rock. By natural process the vegetable matter will be changed into peat or coal; or, if the process of decomposition is more rapid and complete, the final result will be oil fields and gas areas. Many of the processes of nature are inconceivably slow, and man cannot estimate the time required to produce a geological formation except by ages of indefinite extent. Years and centuries in this connection become as mere seconds of time. These apparently slow processes will be continued without intermission century after century, until finally a great geological formation is built up, and the ocean itself is shifted to another quarter of the earth.

This shifting of oceans and seas has continued for measureless ages. The land areas in which our gas-fields lie were for inconceivable periods beneath broad seas. The rocks at the various gas horizons, and those above and below them, are full of the remains of organic bodies similar to those that inhabit existing seas. Thousands of species of shell-fish have been identified, but how many thousands of species once existed of which no trace has ever been discovered is wholly beyond conjecture. It is enough to know that these fish existed in some waters in such vast quantities that the oyster-beds and mussel-shoals of the present day are insignificant in comparison with them. In hundreds of places where limestones occur masses of the stone, dozens of feet in thickness, are composed wholly of the perfect or comminuted shells of ancient orders of these fishes. In fact, almost the entire limestone formation of the globe is composed of the comminuted shells of these denizens of ancient waters. It is reasonable to assume that the softer portions of these animals contributed largely to the stores of gas and petroleum found in our limestones. In addition to these, countless myriads of crustaceans swarmed in the waters of the ancient oceans, besides other orders of animals innumerable. Some of the rocks disclose vertebrate remains, such as fishes and reptiles, in such vast quantities that they compose almost the entire body of the rock. Such for instance are some of the phosphate-beds of the south.

Besides the animal remains found in the rocks, there are found vegetable remains that indicate a profuseness of growth in this kingdom far surpassing the product of the richest forests and jungles of the tropical regions of to-day. Many of the seas were filled with a plant growth similar to the seaweeds of to-day. Remains of these are found profusely through the rocks. Evidences of these plant growths are found in greater or less abundance in all the stratified rock deposits. All the great coal deposits of the earth are but partially decomposed portions of the wonderful vegetable growth of past ages.

More or less mineral matter enters into the structure of all animal bodies. The shells of oysters, crabs, and turtles, and the bones of animals, contain a greater proportion, and these are the parts that are universally found in a fossil state. The softer parts of the body soon decompose, and the gaseous portions are dissipated in the air, or confined in some reservoir. Trunks of trees are more readily preserved, and these are found in all states of preservation, from the semi-lignitic state to that of pure coal.

Coal is found in various states of preservation. In the process of decomposition we have wood, peat, lignite, bituminous coal, cannel coal, and anthracite. The last, anthracite, is virtually natural coke. It was once bituminous coal, but in nature's laboratory, or oven, it has been converted into anthracite by slow processes, but by the same laws that govern when bituminous coal is placed in the cooking oven. Coke is artificial anthracite, just as the gas evolved in a cooking-oven is artificial gas. The texture of anthracite was modified by the condition of environment and the weight of superimposed strata during the process of gas elimination.

The preceding statements have been made for the purpose of showing that great masses of organic bodies, both animal and vegetable, capable of yielding gas in unmeasurable quantities, were distributed throughout all the stratified-rock deposits during the rock-building periods of the past. Gas and petroleum have been found only in the stratified-rock deposits. They are never found in the granites or in other igneous rocks that are barren of organic remains. The sedimentary, or stratified rocks of the various oil and gas areas lie over the igneous, or non-stratified rocks. If gas was generated in the lower rocks, it might readily by its expansive force propel itself into reservoirs in the superincumbent strata, but petroleum would not ascend unless forced upward by hydrostatic pressure. But in face of the fact that neither gas nor oil have ever been found in the igneous rocks, none will care to assume that petroleum has been forced into its position in the superlying rocks by pressure such as suggested above.

Assuming that natural gas was generated in the rocks that now confine it, an examination of these rocks and contiguous rocks ought to determine as to the probability of the gas having been produced by a partial dissolution of the rock structure. Careful analyses of the gas-bearing rocks of Ohio and Indiana have been made from time to time, and it has invariably been found that the samples examined have undergone no material chemical change. In some localities the rock that forms the reservoir is a nearly pure carbonate of lime. In other localities it is a sulphate of lime or magnesian limestone. In all cases it is crystalline, or semi-crystalline, in structure. There has been no general decomposition of this rock or of that contiguous to it. The rock is composed of small crystals of lime with interstices between that form the so-called " pores " in which the gas is confined. The capacity of the reservoir is determined by the size of these interstices, the thickness of the rock, and its lateral extent.

With a knowledge of the fact that there has been no material change in the component elements of the rocks at the gas horizon, and the knowledge, also, that the underlying igneous rocks are barren of gas and have not the elements to produce it, it is easy to arrive at the conclusion that natural gas has been derived from the organic matter that was buried with the sediment that now forms the rocks. This is equally true of the gas found in Pennsylvania and West Virginia, as well as that of Ohio and Indiana.

Another fact in this connection is that all geological formations from the Trenton group, upward, contain more or less gas and more or less petroleum. This is important considered with the fact that all of these formations and groups of rocks are full of organic remains. The Utica shales, overlying the Trenton limestone in Ohio and Indiana, have a maximum of thickness of 400 to 500 feet. They are usually black and are in places highly bituminous. The Niagara limestones in Indiana, Kentucky, and Tennessee contain more or less petroleum distributed almost universally through their strata, and in some localities considerable deposits of asphaltum occur. The Devonian shales of Tennessee, Kentucky, and Indiana are rich in petroleum, but as a rule they lie so near the surface that the oil has largely evaporated or changed into gas, and has been dissipated in the air. In Meade county, Kentucky, and Harrison county, Indiana, the limestones underlying the Devonian shales yield gas in paying quantities and also petroleum to some extent. Petroleum is mentioned in connection with natural gas for the reason that they are uniformly associated in the rocks or are found contiguous to each other, and it is assumed they both have the same origin. In fact petroleum is the residuum of natural gas, just as asphaltum in many places is known to be the residual matter of evaporated petroleum. Petroleum is the only element now left in the rocks from which the supply of natural gas may be replenished.

The fact seems plain that natural gas is of organic origin, though it may be remotely so. First petroleum is distilled, and following, possibly, gas is generated. This being true, why do not all areas where stratified rock occur have natural gas? First, because over many areas where organic matter was deposited in large quantities the conditions were such that immediate decomposition took place and the gas escaped into the air. Second, in many large areas where gas was generated, probably in immense quantities, subsequent disturbances fractured and fissured the strata to a great depth, thus releasing the imprisoned gas from its reservoir. Then, there were doubtless large areas of the ancient oceans almost barren of organic life, just as portions of existing seas are almost destitute of life, and these areas are naturally destitute of gas and petroleum in paying quantities. The meaning of "sedimentary" and "stratified," when applied to rock formations, is generally understood. It is known that these are the rocks that were formed by deposition in seas and other bodies of water. The matter composing these rocks was first deposited as mud, sand, or gravel. The rocks derived from these depositions form shales, sandstones, and limestones, with various minerals interspersed through them. It is doubtless true that mechanical and chemical action both contributed to produce the transformation from mud and sand to stone. It was during this period of metamorphic action that the petroleum confined in the rocks was distilled and the natural gas generated from the decomposing organic matter. The organic matter confined in the sediment during the period of metamorphic action was wholly decomposed. Nothing remains of it except the mineral portion. There is no further store upon which nature can draw to replenish the oil and gas fields when they are once exhausted. Ultimate exhaustion is an absolute certainty. The gas reservoirs will become as barren as will the coal fields when the coal has all been mined.

Natural gas in commercial quantities is confined to limited areas, and, necessarily, it is limited in amount. As already stated, there is but one source from which the exhausted areas may be replenished and that is from the petroleum confined in the same rock reservoirs. The conditions that prevail in the strata containing the petroleum are not favorable for a a rapid generation of gas. The temperature of the rocks is too low. The temperature of the water in the deep wells of Ohio and Indiana is never found to be above 60° F. The average temperature of the water in the deeper wells is about 55°. This is much too low to produce a rapid transformation of petroleum into gas. It would require a temperature at least three times as high to produce a rapid generation of gas. The stock of gas now confined in the various reservoirs is all that can ever be made available for use. Even if there was a sufficient generation of gas from petroleum to keep up the normal pressure in the wells and mains, the stock of petroleum would finally be exhausted, and then the supply of gas would as certainly cease.

This one important fact is plainly apparent: The supply of gas for practical use is certainly limited. How long it may be made available for economic purposes must be decided in the future. Its permanency depends largely upon the use made of it. For the past eight years it has been extravagantly and foolishly wasted. For a period of nearly one year there was a daily waste in the State of Indiana alone of more than 100,000,000 cubic feet. The daily loss to the people of Indiana on account of this enormous waste was more than $10,000. It is estimated that 30,000 cubic feet of gas in the Indiana field is equal to a ton of the best coal in stoves or furnaces. Coal delivered in the Indiana gas-fields is worth $3.25 per ton. It is not an extravagant statement to assert that the cash value of natural gas wasted in Indiana since its discovery would be more than $20,000,000,—an amount greater by far than the total capital invested in these fields on account of cheap fuel. The waste is still going on at the rate of 25,000,000 cubic feet daily. Hundreds of flambeaus, consuming on an average 2000 cubic feet of gas per hour, have been allowed to burn day and night, without interruption, ever since the beginning of developments in the gas area. Hundreds of unprofitable wells are not plugged, but are left wide open and the gas allowed to escape into the air. This is especially true of the section of the field where petroleum is found in connection with gas. Scores of isolated wells that have been drilled for oil yield gas in large quantities, but they are not connected with pipe-lines, and the oil is saved, but the gas permitted to waste. Reckless extravagance also prevails in the use of gas, both in factories and private houses. Gas, in the Indiana field, is not sold by measure, but it is supplied for factory or domestic purposes at a fixed price per month. It makes no difference whether much or little is consumed, the price is the same. It costs no more to continue the fires twenty-four hours in the day that it does one hour. With this state of things existing the consumer has no interest in practising economy. Fires are allowed to burn continually in unoccupied rooms and unused furnaces, without regard to the value of the fuel consumed. If gas were sold by measure for all purposes, consumers, especially, would practise economy. The statement may seem extravagant, but it is doubtless true that at least 40 per cent. of the gas consumed in the Indiana field, factories, dwellings, etc., is actually wasted.

But one result can follow this extravagance, and that is a quick exhaustion of the field. A final exhaustion is inevitable, under any circumstances, but the profligacy that now prevails is destroying the field at a two-fold ratio. With economy in its use natural gas will bring capital and prosperity to the field for years to come, but the quick exhaustion that will surely follow the extreme prodigality of the past few years will necessarily result in the abandonment of the field, to a certain extent for manufacturing purposes.

Gas is most beneficial when consumed for domestic purposes. In this way it benefits a much larger proportion of the population, and there is also more profit to the producer in selling it for domestic use. As the volume of the supply gradually decreases, it will necessarily be withdrawn from use in the factories and the supply confined exclusively to domestic use.

It is well to note that at this time there is a united action on the part of the various companies producing natural gas throughout the various fields looking to its preservation, and endeavoring to secure rigid economy in its use. If these efforts are successful, the period of prosperity now prevailing throughout the gas areas will be materially lengthened.

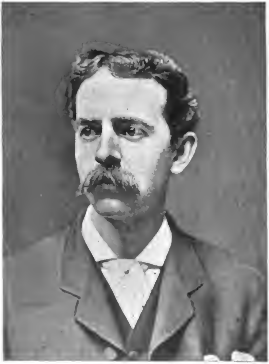
SCULPTORS OF THE WORLD'S FAIR.

By J. H. Gest.

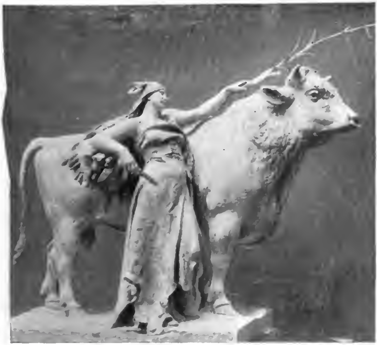
WHATEVER may be the success of the World's Columbian Exposition as an exhibition of the liberal and mechanical arts, or of natural products, it has achieved in one respect a result that could not reasonably have been expected, and certainly could not have been foreseen in its actual magnitude. In 1889 France presented to the world an architectural and artistic spectacle unapproached by former exhibitions, and until within a few months past the last French exhibition remained the ideal in the public mind. Almost no one had thought of an American exhibition which in the architectural beauty of its buildings, and especially in their sculptural decoration, should in any way rival Paris of 1889.

Conceding the ability of our architects to carry out their part of the task, where were the sculptors capable of acceptably decorating the buildings? To do this work required not only one man, or a half-dozen men, but a score or more of trained sculptors supported by a corps of personal assistants, and a small army of subordinate modelers and molders. They must be men fertile in the invention of a kind of ornament for which comparatively little use has hitherto been found in this country,—not men capable of modeling merely detached statues, but able also to do it in harmony with architectural surroundings. This aspect of the sculptor's art is almost entirely unknown to the Americans as a people, who for want of knowledge have really no conception of its uses and its value in civic and national life. Even those of us who have occasionally the good fortune to travel in Europe, and who bring back in memory, and in photographic scrap-books, impressions of the architectural and sculptural interest of European towns large and small,—even they drop back into the practical course of the overpowering commercial and mechanical movements peculiar to our civilization, and ere long become content with the bald surroundings of brick and stone amidst which the large percentage of our population live and labor. If even these favored few do not sufficiently value the presence of beauty of sculptural form as a leaven in the hard commonplace of our cities, how can the less fortunate, to whom this beauty is as unknown as though it had no existence?

It may be asked: What is the value, to a civilization like ours, of the esthetic expressions in form which are the products of the sculptor's art? Some years ago esthetics seemed entirely apart from the proper course of our lives. The usefulness of art was practically unknown, and even recreation was indulged in either under compulsion or with an unhealthy excitement. It is now generally admitted that of all the means of mental recreation none are so nearly inexhaustible as art, and in none can the restful influence be so ever-present. This is acknowledged in our strenuous efforts to introduce beauty into the most humble of the industrial arts, which is the marked characteristic of our industrial advance since 1876. All of this reaches the homes of the people and introduces an esthetic leavening of growing force. Art museums and galleries of paintings and sculpture are carrying the movement forward on a higher plane. But we have just begun to appreciate the fact that buildings, public and private, should themselves teach the value of beauty of proportion, of mass, of form in outline and surface, and even of color. Here the sculptor's work joins that of the engineer, architect, and builder. When the capitalist has employed the engineer to plan his enterprise, the architect to give his building not only adaptability to its use but

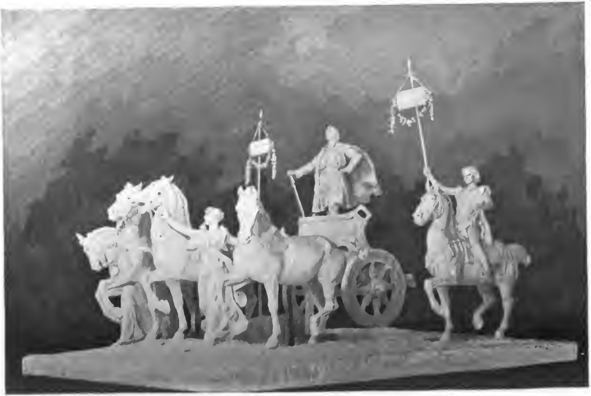


DANIEL CHESTER FRENCH.



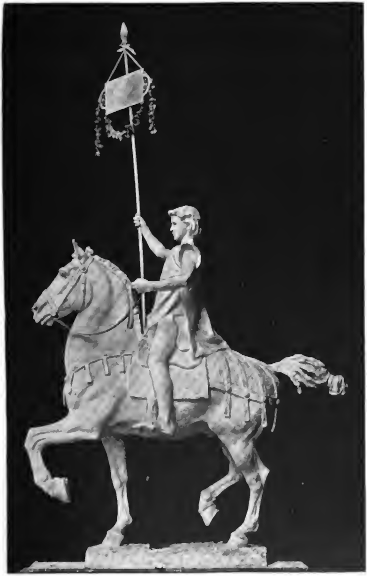
"INDIAN CORN."
[By Daniel C. French and Edward C. Potter.]

also a character that shall be its entity as compared with others, then steps in the sculptor to ornament, until the whole shall possess not only utility but a beauty which shall make acceptable and perhaps emphasize that very utility. The finished work is thus by its attractiveness made even more efficient for the purpose for which it was intended. Other things being equal, the increased rental of the building will pay the interest on the cost of the sculpture. And the city with fine public squares, artistically dressed with statuary in appropriate architectural settings, will thrive as compared with the rectangular, monotonous, bald, utilitarian town, provided the location and other commercial conditions be not too unfavorable. Further, this ornamentation of a city stimulates its pride,—a force constantly active in advancing a community. The streets should, so far as public and private enterprise can make them, be as popular museums full of object lessons that will tend to make



QUADRIGA—"THE TRIUMPH OF COLUMBUS."

[Figures by Daniel C. French; horses and herald by E. C. Potter.]



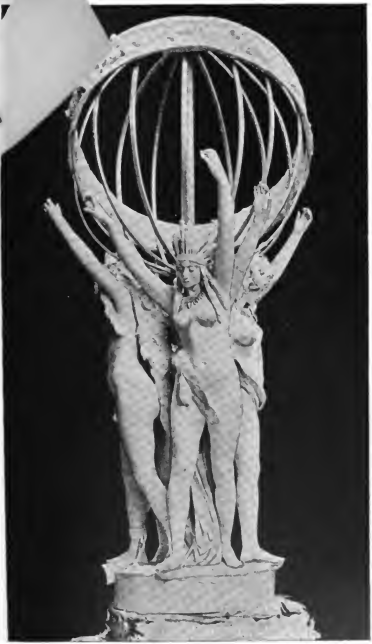
HERALD OF THE QUADRIGA GROUP.

good citizens. One of those lessons is the evidence of thrift given by the bustling crowd, another is the stability of buildings, but still another should be the appropriateness and the architectural and sculptural beauty of these same buildings. All this provision for his enjoyment of life tends to add something to the capacity of the citizen for activity.

There is no doubt as to the impression that will be made upon thousands of visitors to Chicago this year. The beauty of grand buildings harmoniously grouped in Jackson Park, the charm of decorative sculpture, the richness of public places and avenues abounding with statuary, create an unsuppressable longing that something of this, apparently so permanent, yet really so temporary, may remain as a lasting impression upon our people. While not attempting to distribute the credit for the beauty of these buildings and grounds, we may well recall that, when the use of Jackson Park—then largely swamp-land—was under discussion, it was Frederic Law Olmstead, the landscape architect, who conceived the plan of dredging lagoons and canals to secure sufficient earth for fills upon which to place the buildings, thus meeting the practical demands of the occasion, and providing the opportunity for artistic effects of land and water. Then followed the grouping of the buildings, of which much was prompted by Mr. Root, though conferences among the chosen architects led to the arrangement finally worked out, and to the adoption of the prevailing style of classic architecture. Coming to the sculptural ornamentation of the buildings and grounds, we should probably find Augustus St. Gaudens the dominant power, though his own work is limited to the gilded "Diana" on the main dome of the Agriculture building, whither it was removed from the tower of the Madison Square Garden, New York. These names, coupled with that of D. H. Burnham, the director of works, are those one hears from all who speak of the enterprise.

So extensive has been the use of sculpture that its enumeration in detail is out of the question in a single magazine article. All that can now be done is to convey a general idea of its character, and to urge upon the visitors to Chicago a more exact examination of it, especially from the point of view presented in the preceding pages.

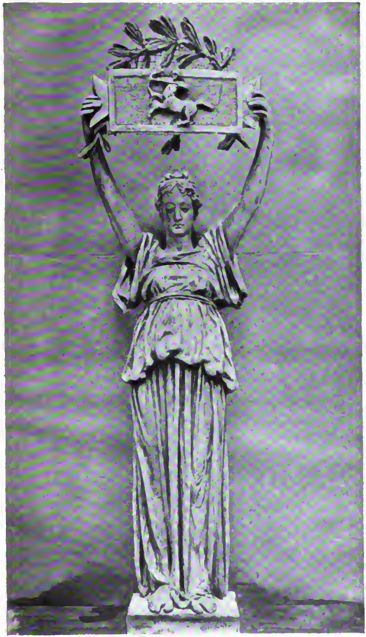
While the buildings throughout have been beautified more or less by the judicious use of architectural ornament and sculptural decoration, it is about the great basin that we find the sculpture



"THE FOUR RACES SUPPORTING THE HOROSCOPE" ON TOP OF THE AGRICULTURE BUILDING.
[By Philip Martiny.]

most abundant. It would seem as though architects and sculptors alike had striven their utmost to demonstrate here the value and the resources of their combined art. This main court, or plaza, of the exhibition extends from the lake toward the west about 2000 feet, and is 700 feet wide. Its eastern portion contains a basin 1100 by 350 feet, which terminates toward the west in front of the Administration building, while the court extends beyond this to the railway terminus. The most important of the exhibition buildings line this court, passing the Administration building on either side, and enclosing the great basin toward the lake. At the lake end a peristyle with four rows of pillars and sixty feet high connects the lateral lines of buildings, while from the centre of the peristyle rises to a height of 150 feet the Columbus arch, upon which has been placed the colossal Quadriga group by Daniel Chester French and Edward C. Potter, his pupil. The figures in this group are twelve feet tall and the plinth measures forty feet. It represents the Spirit of Discovery, Columbus entering in triumph in his chariot, the horses led by graceful maidens, the whole flanked by two heralds, boys carrying standards. The figures of Columbus and the two maidens are by French; all the horses and the boy heralds are by Potter. The first impression is one of dig-

PHILIP MARTINY.



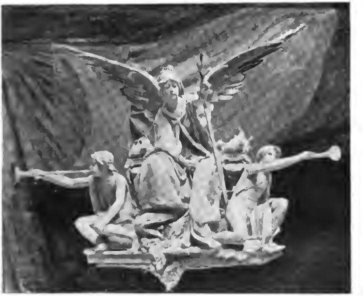
GIRL HOLDING A SIGN OF THE ZODIAC—AGRICULTURE BUILDING.

[By Philip Martiny.]

nity, produced by the fine lines of the composition and the noble beauty of the figures, after which one realizes the great vitality of both figures and horses, which, though restrained, are full of action. I do not know anything finer in modern monumental sculpture than the Quadriga and French's truly colossal "Statue of the Republic" rising from the basin some distance in front of the arch to a height of one hundred feet, the statue itself being sixty-five feet tall. The Quadriga upon the high arch in the peristyle forms really the background for the "Statue of the Republic," and the two must be considered together.

KARL BITTER.

"The Republic" is a statue of exceeding dignity, tall, stately, with serene countenance, beautiful in a grand abstraction that finely symbolizes the noblest aspects of our national character. I cannot speak too highly of the monumental grandeur and beauty of the "Republic" and the "Quadriga." In addition to these French and Potter have modeled four colossal groups for pedestals on the roadways on either side of the basin in front of the Agriculture building and the Manufactures and Liberal Arts building on the opposite side of the water. The figures are twelve feet high, and the animals in proportion. The subjects are an Indian maiden standing beside a bull, typifying "Indian Corn," and another maiden



GROUP ON TOP OF ADMINISTRATION BUILDING.
[By Karl Bitter.]

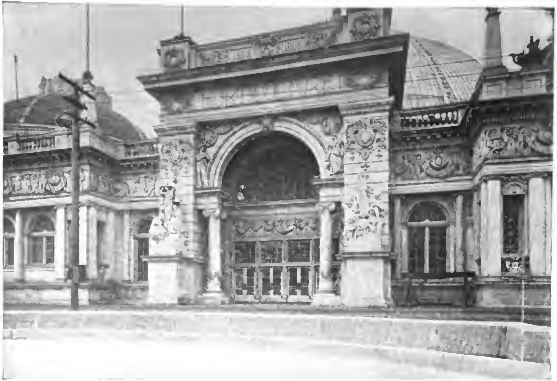
also beside a bull, representing "Wheat." On the opposite side of the basin a "Young Farmer" stands near his horse, and the "Negro Teamster" is similarly placed. Each group being repeated, there are eight in all. Unpretentious, in quiet easy action, or in repose, these groups are heroic with a certain latent vigor.

Daniel Chester French is of New England extraction, born in Exeter, N. H., in 1850. In boyhood, at Concord, he became interested in modeling in clay, through the kindly attention, it is said, of Louise M. Alcott. For a short period he studied under Dr. Rimmer, the well-known anatomist and lecturer. In 1870 he became a pupil of J. Q. A. Ward. As Mr. W. Lewis Frazer says, he "did not go abroad until his style was formed, and he had seen one of his own works (the statue of 'The Minute Man') erected at Concord Bridge in 1875. In fact the whole period of his foreign art-study is covered by the two years spent in the studio of Thomas Ball in Florence and one year in Paris." In addition to the "Minute Man" (1874), may be mentioned "John Harvard" (1883), "Lewis Cass" (1887), "Dr. Gallaudet and his First Deaf-Mute Pupil" (1888), "Thomas Starr King," "The Angel of Death Staying the Hand of the Sculptor" (Milmore memorial, 1891), for which he received a third-class medal in the Paris Salon.

The name of Edward C. Potter naturally follows that of his master, Daniel C. French, on account of their close connection in the Quadriga and other groups. Potter is a young man, born in New London, Conn., thirty-five years ago ; studied in the school of the Museum of Fine Arts, Boston, and simultaneously with French. Later he worked in Paris under Frémiet and Mercié. His present commissions in Chicago are really the first important ones executed by him, but their great excellence should lead to the immediate recognition and rapid advancement of this vigorous young artist. They are the Heralds of the "Quadriga," horses and boys, the four other "Quadriga" horses, and the cart-horses and bulls. He also has on the New York building two lions after the antique. In the Art Institute is a "Marble Faun" and in the Senate chamber at Washington a bust of Vice-President Wheeler, by him.

LORADO TAFT.

I have dwelt at some length upon the work of French and Potter because of the prominence of its position as really the key to the

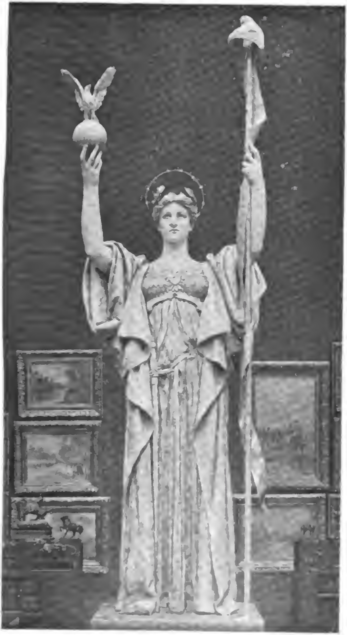


PORTAL OF HORTICULTURE BUILDING, SHOWING "SPRING" AND "AUTUMN" GROUPS.

[By Lorado Taft.]

scheme of sculptural decoration of the main court. The other most important detached work of sculpture is the great fountain at the west end of the basin, opposite the "Republic" and "Quadriga." This Columbia fountain, one of the largest in the world, occupies a circular basin about 150 feet in diameter, directly in front of the Administration building. The composition is an embodiment of the spirit of modern liberty. Seated high upon a triumphal barge, Columbia is rapidly driven forward by eight standing oar-maidens, representing the arts on the one side, and, on the other, the sciences, industry, and commerce, while the herald Fame stands at the prow and Time at the helm. Sea-horses without-riders form a circle in front, and surrounding dolphins cast up jets of water. The figures are over twelve feet in height. On the sides rise fifty-foot columns surmounted by eagles. It will be seen at a glance that the spirit of the composition is movement, and this idea the artist has expressed in charming variety and freshness of form, preserving at the same time in the pose of the figure of Columbia a suggestion of a fixity of purpose. It is regretted that a satisfactory view of this fountain cannot be presented here, as it is a very important work in

CARL ROHL-SMITH.



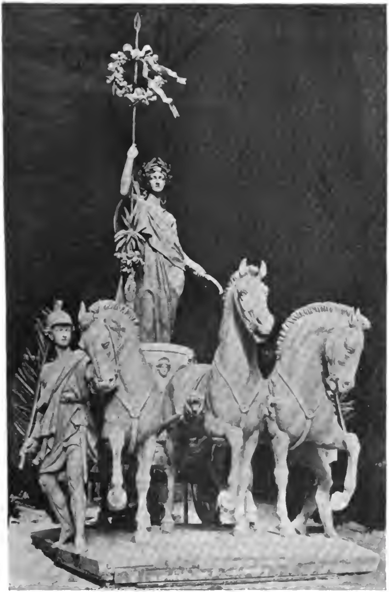
STATUE OF "THE REPUBLIC."
[By Daniel Chester French.]

the present development of modern sculpture. Frederick MacMonnies is a young man, of native birth, and received his preliminary training under St. Gaudens in New York. Since then he has been in Paris for some years, and has attracted by his work in the Salons the frequent notice of artists.

To another pupil of St. Gaudens was entrusted the decoration of the Agriculture building, one of the most prominent in position and therefore requiring exceptional skill and thought in its decoration. I refer to Philip Martiny. Born in Strasburg of French parents in 1858, he came to this country to escape conscription. He had from the age of fifteen worked at modeling, studying first with Eugene Doch. In New York he became a pupil of St. Gaudens, and afterward assisted him in various undertakings. Among his works are the bronze medal of Washington, for the Washington centennial, New York; the spandrels of the Brooklyn arch; and the proscenium panel for the Madison Square Garden; and he is now executing a commission for the Art Institute building, Chicago.

M. A. WAAGEN.

The sculpture on the Agriculture building has, of course, been made appropriate to the intention of the building. It is all by Martiny, with two exceptions,—namely, the "Diana" by St. Gaudens on top of the central dome, and the pediment group, "Triumph of

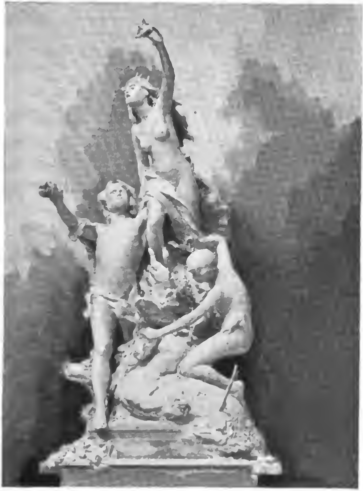


GROUP ON COLONNADE BETWEEN THE AGRICULTURE AND MACHINERY BUILDINGS.
[By M. A. Waagen.]

Ceres," by Larkin G. Meade. On the pavilion domes Martiny has placed a beautiful group of four female figures representing the "Four Races Supporting the Horoscope." On the four corners of the building are groups of three seated female figures holding aloft garlands. They represent the seasons. The eight main piers are surmounted by finely-composed cattle groups, either a woman standing between two cows facing out, or a man between two horses in similar pose. The small pediments are also filled with sculpture. Then, on each of the piers all the way round the building, stands a stately female figure holding aloft a panel bearing a sign of the zodiac. There are also fifty-two figures of "Abundance" repeated as an ornament about the façade of the building. Consider in connection with this the architectural beauty of the building in design, and the subordinate ornament in moldings and various kinds of relief modeling, and one may form some conception of the richness of effect. There is in Martiny's work a classic grace, an appreciation of refinement in form and of line in composition, that give it a subtle charm.

JOHN J. BOYLE.

Larkin G. Meade, referred to above as the sculptor of the main pediment of the Agriculture building, was born in New England in 1835, and has for many years occupied a prominent position



"FIRE UNCONTROLLED"—IN PORTAL GROUP ON THE ADMINISTRATION BUILDING.

[By Karl Bitter.]

among our older sculptors. Since 1862 he has passed the greater part of his professional life in Florence, Italy. Among his important works is the statue of Lincoln for the national Lincoln monument, Springfield, Ill. The present pediment group is "The Triumph of Ceres."

Another of the notable buildings is that devoted to Administration, the prominent location of which has already been referred to. On this account its sculpture was planned on the most liberal scale, and the sculptor selected for the task is Karl Bitter, whose work is characterized by unusual spirit and vitality. Whether we view it as symbolizing the tireless activity of our American life, or the indomitable enterprise of Chicago and its World's Fair, the decoration of this building is equally appropriate, and in that sense it takes its place well with the other sculptures of Jackson Park. Its very exuberance has a reason for existence in Chicago. Large groups of statuary and colossal single figures are placed at the base of the tall octagonal dome, and on the corners of the pavilions, to connect the dome with the rectangular mass below, while other groups enrich the portals. At these entrances the four elements give subjects to the compositions. On the pavilions are represented national characteristics, such as heroism, love of liberty, etc. At the point from which the dome springs are allegorical groups representative of culture,—"Art," "Science," "Industry," etc. This will convey some notion of the spirit of the sculptor's art.

EDWARD KEMEYS.

Karl Bitter was born in Vienna, Austria, in 1867, studied there in the Kunst-Gewerbe Schule and the Imperial Academy, and worked upon the sculpture of the new Imperial Museums. In New

York for about four years he has been commissioned to make the principal of the Astor memorial gates for Trinity church, has executed figures for George Vanderbilt's gallery, caryatids for the Belmont tomb, and marble figures for the Vanderbilt house at Newport.

The Manufactures and Liberal Arts building, with its great roof, has consistently been kept simple in character, the façades broken only by the low arches of the encircling colonnades and the high arches at the portals. These latter have spandrels by Karl Bitter, who also modeled the mammoth eagles upon the columns near the entrance. Otherwise there is no sculpture to attract attention.

CROUCHING ANIMAL, ON A BRIDGE ABUTMENT.

[By Edward Kemeys.]

But, opposite the Manufactures building, toward the south, on the other side of the lagoon, is the important Horticulture building with sculpture by Lorado Taft of Chicago. Here, as on the Agriculture building, the decoration is suggested by the use of the structure. The sculptor writes: "The principal sculptural decoration of the building consists of two large groups, just outside the principal entrance. On the one side is the artist's idea of Autumn. The composition has been called the 'Sleep of the Flowers.' The sculptor endeavored to suggest here the quiet, almost melancholy, spirit of autumn, and with this object in view has kept all lines as harmonious and graceful as possible. The faces of the two sitting figures suggest sleep, and even the standing figure looks mournfully down upon them, as though she too would join them in their slumbers. The only touch of animation is the single belated cupid who sits contentedly absorbing a bunch of grapes. . . . On the other hand is the Springtime group, sometimes called the 'Battle of Flowers.' In this the artist has tried to express the vigor and push of awakening vegetation by means of broken and angular lines, making the composition as great a contrast as possible to the Autumn group. In this we have the figures of three nymphs, a faun, and two cupids, all laughing heartily as they pelt each other with buds and blossoms. The faun is engaged in binding a garland around the waist of the central figure, while she in turn has her arms full of flowers which she uses in her mimic warfare. The figures in these groups are about eight feet in height. . . . Just inside of the vestibule stand two figures, each ten feet in height. The one on the right is a light airy personification of 'Flora.' . . . On the opposite side is a figure of 'Pomona.' . . . On the eastern front of each pavilion at the ends of the building are two figures placed on the level of the second story. The one on the south is the 'Painting of the Lily.' . . . The next figure is symbolic of the cultivation and use of the grape, and represents a faun, a joyous, soulless creature, holding in one hand a brimming beaker, and in the other a bunch of grapes." The corresponding figures on the north are a woman representing "Botany," and a man representing a gardener examining the bursting buds of a vine. The building is further surrounded by a broad frieze of boys supporting garlands. The compositions are rich and full of pictorial interest, harmonious in lines and masses, and make the building one of the most interesting in the quiet richness of its ornamentation.

Lorado Taft was born in Illinois, studied at home, and later in the École des Beaux-Arts, Paris, as well as under Mercié. Among other works may be mentioned the Grant Statue at Fort Leavenworth. In addition to working in his own studio, he directs the classes in modeling in the Art Institute, Chicago.

The simple, but noble, Fine Arts building, in architectural proportions probably the most satisfactory in Jackson Park, has comparatively little sculptural decoration. There are, however, figures by Martiny representing Painting, Architecture, Sculpture, and

Music, and a Victory. Olin L. Warner has also contributed to its ornamentation relief portraits of great artists. Born in this country in 1844, Warner studied in the Beaux-Arts under Jouffroy, and later under Carpeaux. His "Shepherd Fountain" in Union Square, New York, and many of his portrait busts are familiar.

The Transportation building has sculpture by John J. Boyle, who was born in New York shortly after 1850, studied at the Franklin Institute, the Pennsylvania Academy of the Fine Arts, and in the École des Beaux-Arts, Paris. A group by him stands in Fairmount Park, Philadelphia. The subjects for the statuary upon the Transportation building relate entirely to transportation, and consist of realistic representations of great inventors in that direction, or of men engaged in that pursuit,—for example, "Brakesman," "Pilot," etc.

M. A. Waagen, a German sculptor, pupil of Kiss of Berlin, and later a resident in Paris, is mentioned in connection with statues on Machinery Hall, jointly with Robert Kraus, whose work is also upon this building.

The Danish sculptor, Carl Rohl-Smith, now living in Chicago, modeled the colossal statue of Franklin under the hemicycle portal of the Electricity building. The figure is colossal, and has the head thrown back and face upturned suggestive of his familiar experiments. The position of the statue is prominent, and it is well relieved against the shadowy background of the great portal. An illustration of this statue appeared in THE ENGINEERING MAGAZINE for March, 1892. The sculptor was born in Denmark in 1848, studied at the Royal Academy in Copenhagen, and later in Italy, France, Germany, and Austria. Among his works are a statue of "Ajax," a bronze statue of Judge Reid in Mt. Sterling, Ky., a marble statue of Colonel Montgomery in Memphis, Tenn., and a bronze statue of "The Hero of the Alamo," at Austin, Texas. He is at present engaged upon an important group for George M. Pullman commemorating the Fort Dearborn Massacre.

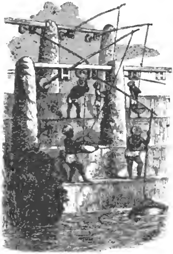
The Woman's building has also received its share of sculptural decoration, and from the hands of women. The main feature is the pediment by Miss Alice Rideout, of San Francisco, an allegorical embodiment of woman's work and power. The caryatids on the building are by Miss Enid Yandell of Louisville.

Of the other sculptures on the grounds we can stop to mention only the representations of American wild animals seen everywhere crowning the abutments of the bridges across the lagoons. These are by the two Americans, Edward Kemeys and A. Phimester Proctor. Both are hunters, and students of the life of wild animals. Kemeys was born in Georgia, was a captain of artillery in the Civil War, then a farmer, and civil engineer in Central Park. His work is seen in Central Park, New York, in Fairmount Park, Philadelphia, and in other places. He is now engaged on two colossal lions for the approach to the new Art Institute, Chicago. A. Phimester Proctor was born in New York, and studied in the Academy of Design and in the Art Students' League.

It is hardly necessary to say that much other sculpture must remain unmentioned in an article of this length, the purpose of which is rather to call attention to the wealth of ornamentation of this character that has been employed in Jackson Park, and by pointing out its use, and its propriety there, to further the conviction that what has been here done for a temporary purpose ought to be followed in the permanent decoration of our towns and cities, their buildings as well as their public spaces. This coöperation of architects and sculptors is in itself an important lesson, for the building upon which sculpture is to be employed must in design be adapted to the sculpture which is to be placed upon it, quite as much as that sculpture must be in keeping with the architecture. Nor can these results be attained unless the builder be ready to allow to his architect and his sculptor sufficient latitude in the conception and treatment of the subject to secure a clear, consistent, and harmonious expression of their ideas of construction and ornament. Not that the purpose of the building shall in any way be sacrificed to secure artistic effect, for it is the first business of the architect to preserve the utility of the structure. The World's Fair has demonstrated an unexpected ability on the part of our architects to deal with plans of unlimited magnitude, and a totally undreamed-of capacity in our noble band of sculptors, of whom we may well be proud in the face of all the world.

THE DEVELOPMENT OF THE MODERN STEAM PUMPING-ENGINE—I.

By William M. Barr, M. Am. Soc. M. E.



PRIMITIVE METHOD OF RAISING WATER.

[From an old print.]

MACHINES for raising water may be said to be as old as civilization itself, and their invention extends so far beyond written history that no one can say when the art of lifting and distributing water began. Egypt, the land of unfathomable antiquity, the oldest civilization of the Orient, noted not only for her magnificence and power but for knowledge, wisdom, and engineering skill, understood and made practical use of such important hydraulic devices as the siphon and the syringe, the latter being a remarkable invention and the real parent of the modern pump. Whether or not syringes were ever fitted with inlet and outlet valves, thus making the single-action pump, is not known ; but bellows consisting of a leather bag set in a frame and worked by the feet, the operator standing with one foot on each bag, expelling the inclosed air, the exhausted bag being then lifted by a string to refill it with air, implies the use of a valve opening inward, and it is difficult to conceive of a continuous operation without one.

A representative piece of mechanism occurs frequently on the sculptures of early Egypt. It has the appearance of, and is generally believed to be, that of a portable pump. The hydraulic screw is also attributed to this people, but their main reliance seems always to have been the *Shadôof*, seen everywhere along the banks of the Nile, an invention so simple and so well adapted to their needs that it remains to day substantially the same as it has through all the centuries since history began.

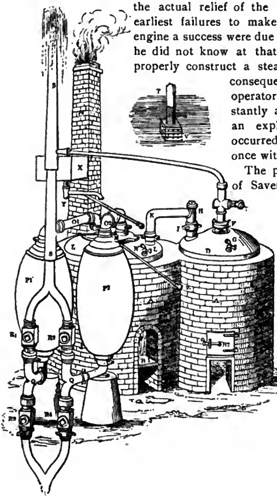
The same may be said regarding the chain-pump in China, an invention the origin of which antedates the Christian era. This simple machine, which seems never to have been improved upon, is in such common use that every agricultural laborer is in possession of one. Where irrigation is conducted on a larger scale, the chain-pump is made proportionally larger and moved by a very simple tread wheel; and still larger ones are operated by yoking a buffalo or other animal to a suitable driving machine.

The application of steam to raising water is of uncertain origin. Long before the Christian era certain applications of fire to vessels containing water, by which effects were produced calculated to astonish ignorant worshippers, were practised by the priests of Egypt, Greece, and Rome; but their knowledge seems never to have been turned into any channels of secular usefulness.

Quitting the Orient, and confining ourselves to more recent times, the first application of steam power to raising water in England is included, but not specifically described, in an English patent granted to David Ramseye in 1630. Among the inventions claimed in this patent, one was "to raise water from low pitts by fire" and another "to raise water from low places and mynes, and coal pitts, by a new waie never yet in use."

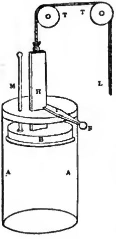
About this time a number of inventive minds were struggling with the same problem. Among the more notable persons thus engaged may be mentioned Edward Somerset, the second Marquis of Worcester, who invented (some years later than the patent of Ramseye) a steam fountain, which is generally included in the earlier inventions in pumping machines. But Worcester's first device was simply a steam forcing machine and lacked the essential elements of a pump. About thirty years later, or say 1663, another machine was constructed by him, having two vessels which were alternately filled with steam; the steam condensing, the water rose by atmospheric pressure and filled the empty space, after which steam was admitted above the water, forcing it to a higher elevation. If only this operation had been automatic, instead of by hand, we should have in this early invention the parent of the modern pulsometer.

Thomas Savery, an English military engineer, patented a "fire-engine" in 1698, and in the year following exhibited before the Royal Society a drawing and model of his invention, which had many of the characteristics of the "water commanding" engine of the Marquis of Worcester. It is not known how much of Worcester's invention was appropriated by Savery, if any, but the champions of the former scouted the idea that the latter had invented anything at all; however this may be, Savery applied his engine to the actual relief of the mines, and his earliest failures to make his pumping-engine a success were due to the fact that he did not know at that time how to properly construct a steam boiler. In consequence, the mine operators were constantly apprehensive of an explosion; which occurred more than once with fatal results.



SAVERY'S FIRE ENGINE.

The pumping engine of Savery, like that of Worcester, had an independent boiler; but the latter was too weak at the joints for safe working at any but low pressures, say from one to two atmospheres, and three atmospheres was in point of fact above the safe limit of pressure. The boilers were of the crudest sort, being no more than large enclosed kettles, or drums, the heating surface being so small that a great waste of fuel followed as a matter of course. The application of steam directly upon the surface of the water to be expelled from the pump chamber occasioned a serious loss of heat, because the sides of the chamber became heated to the temperature of the steam at each expulsion of the water; but with all its defects the modern steam pumping-engine may be said to have started with the invention of Savery's engine about the year 1700. How many of these "fire-engines" were erected we have no present means of verifying; there is reason to believe that a considerable number of them were employed for moderate lifts, but for deep mining operations they seem never to have been in favor.



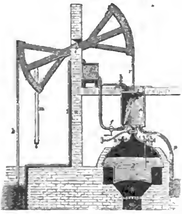
PAPIN'S ENGINE.

The pumping-engine designed in 1690 by Denys Papin (about the same time as that of Savery) consisted of a boiler which also served as the engine cylinder, it being fitted with a movable piston. The bottom of this boiler was made of thin metal to quickly heat the contained water and convert it into steam. The elastic force of the steam so generated raised the piston to the top of the cylinder, a spring latch holding the piston in this elevated position in the cylinder, after which the fire was withdrawn and the steam condensed, forming a vacuum under the piston, which latter, being now unlatched, descended in the cylinder, and by means of a rope lifted the pump bucket. This invention, as a water-lifting device, was both crude and impracticable; and it bears no sort of comparison in point of usefulness with that of Savery. Aside from this impracticability, it marked one important step forward, and that was the employment of a piston in a steam cylinder; and to Papin, therefore, belongs the credit of this important invention.

Thomas Newcomen some years afterwards (1710) designed an entirely new type of pumping-engine proposing "a steam cylinder containing a piston similar to that of Papin's, and to drive a separate pump." After the usual disappointments which seem to accompany all innovations on old methods, this invention gradually worked itself into favor by reason of the intrinsic merits of the machine itself; and the modern pumping-engine may be said to start from this point. The salient features of Newcomen's engine were a separate boiler, a steam cylinder fitted with a movable piston, and the introduction of a water jet in the steam cylinder to hasten the condensation of steam.

We need not enter upon the question as to how much of the above was really original with Newcomen, but simply accept the fact that his was the first practicable scheme for operating pumping-engines by steam. It is true that this engine was not automatic in the necessary movements of the valve-gear ; and it is also true that the application of the water jet within the steam cylinder is objectionable to the last degree from our point of view ; but this does not detract from the merit of the original invention.

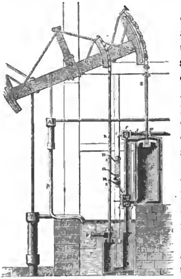
The above engine was greatly improved upon by John Smeaton, (1724–1792), a distinguished civil engineer who gave pumping-engines constructed under his direction better proportions, and secured for them better workmanship than had been employed previously. He also improved upon the steam boiler, and designed a better method of boiler setting, by which a large saving in coal was effected. Smeaton's success, considering the crudeness of even his best designs, as compared with later engines, was really remarkable; and too much praise cannot be accorded him therefor both as an engineer and a mechanic.



NEWCOMEN'S ENGINE.

To James Watt is due the credit of correcting the faults of the preceding inventions for pumping water by steam power. Watt was a maker of philosophical instruments in Glasgow. During the year 1763 a model of a Newcomen engine was sent him for repairs. Watt made a number of experiments with this model and found that it was extremely wasteful of steam ; that as much steam was used at each stroke of the piston as would fill the cylinder three or four times, a loss occasioned by the alternate heating and cooling of the steam cylinder, and that a great advance in economy would be secured if the steam cylinder could be kept hot, and the condensation of the steam be accomplished in a separate vessel kept cold by the application of water or other cold bodies, this vessel being in occasional communication with the steam cylinder, so that the steam could escape from the cylinder into it and be condensed at the right moment.

This invention of a separate condenser, which at this time was a surface condenser only, completely solved one difficulty, but introduced another which, for the moment, was quite as perplexing; and that was the accumulation of water of condensation within the condenser itself, which in a short time would fill it and render it inoperative; but Watt's genius was equal to this emergency, and thus resulted the invention of the air pump.

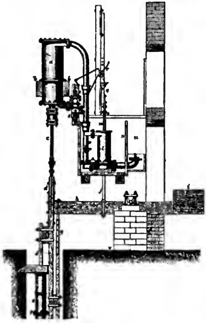

WATT'S ENGINE.

In order to keep the steam cylinder as hot as possible, Watt applied an outer cylinder, filling the intervening space with steam, so that the steam jacket was one of the results of this same investigation and experiment. The expansive property of steam now engaged his attention, the general facts regarding which were soon mastered by him, and an adaptation of the valve-gear to the new requirements enabled him to produce the expansion engine, with its consequent saving in fuel.

In 1773 Watt became associated with Matthew Boulton, and the afterwards famous partnership of Boulton & Watt was formed. Many details of the steam-engine portion of the pumping-engine were improved upon by this firm. In many instances it needed only better workmanship and proper machine-tools to bring that part of the machine to a reasonable degree of perfection. The engine was changed from single to double acting; and, to cheapen its construction, the independent jet condenser was applied to these engines instead of the more expensive surface condenser. This firm, before the year 1788 closed upon them, had produced in their establishment all the essential features of the modern steam-engine.

Previous to 1780 the energies of the preceding and other inventors, such as Murdock and Hornblower, were almost wholly expended in the improvement of machines for "raising water by fire"; but the development of the rotative steam engine and the broader application of steam engineering generally were not only contemplated, but carried into effect. From this time forward a wide divergence in design occurs, and steam pumping-engines are relegated to a distinct class.

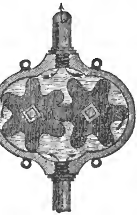
The steam-engine, in its first application, was designed for raising water; and, as it was a single-acting engine, the power was most conveniently applied indirectly through the medium of a vibrating beam. Among the contemporaries of Watt were William Bull and Richard Trevithick. Bull designed a vertical direct-acting pumping-engine, dispensing with the vibrating beam,—a design at once simple and direct. As showing the rapid advances made in the sizes of pumping-engine steam cylinders, it may be a surprise to some to know that, in 1798, an engine with a cylinder 60 inches in diameter, of this type, afterwards known as the Bull Cornish engine, was erected by the above engineers at the Herland Mine, Cornwall. This engine was adjudged an infringement on the patents of Watt, which for a time interfered with its introduction; but such engines were afterwards built in England and in this country. Direct-acting engines placed over the mouth of a mine are inconvenient and sometimes dangerous, and it is for this reason that beam engines are usually preferred; but apart from this the Bull engine was inferior to the regular Cornish engine in practical operation in the lack of sufficient time in transmitting the force of the steam, this occurring with too great suddenness upon the pump



BULL CORNISH ENGINE.

rods, an effect similar to that of a blow, which was both destructive and dangerous.

The Cornish engine does not differ essentially from the single-acting beam pumping-engine of Boulton and Watt. It has long been a favorite in England, especially for deep-mine pumping. It has also been employed in mining and water-works service in this country; but in most cases it has been superseded by other and later forms of pumping-engines. In the Cornish engine the steam pressure is exerted in lifting the pump rods, and usually a heavy weight, to the top of the pump-stroke; the steam pressure being then released, the pump-rods, assisted by the heavy weights attached to the beam, are allowed to descend by gravity, and in their descent the water is expelled at the mouth of the mine, or, if the mine be a deep one, from one level to another in the mine shaft, until the surface of the ground is reached. The Cornish engine is both expansive and condensing. The expansion is secured by the inertia of the pump rods, and, if necessary, by an extra weight added to the end of the beam. As the engine comes to a complete stand-still at the end of every stroke, more steam is required to begin the upward movement of the pump-rods and weight than is afterwards required to keep them in motion, and this energy absorbed at the beginning is given out at the latter end of the stroke, an effect similar to that of a fly-wheel, and which permits of a considerable degree of expansion. This type of pumping-engine is used in some of the deep silver mines in this country, and is said to possess advantages over every other kind of pumping-engine thus employed for excessive depths.



ROTARY PUMP.

The earliest pumping-engines, notwithstanding their crudeness, exhibited an economy favorable to their continued employment as compared with the cost of pumping by horse power. Smeaton made some tests to determine the actual work done by an engine after Savery's plan, and found that 5,250,000 foot-pounds per bushel of coal (84 pounds), or 62,500 foot-pounds of work per pound of coal burnt, was the actual performance, which included that of the boiler also. The Cornish pumping-engines were a great advance upon what had gone before; the reports of the duty attained by some of these early engines do not appear to be as trustworthy as later publications. In 1776 Boulton and Watt guaranteed a duty of 22,000,000 foot-pounds per 112 pounds of coal burnt,—a performance which, at that time, they were not able to make good; but it is said that in a test of a 48-inch engine made some two years later a duty of 27,503,000 foot pounds was reached,—an exceptional performance considering the state of the art at that time.

In 1813 the reported duty of 24 Cornish engines, representing 998 horse-power, burning 3.4 pounds of coal per horse-power per hour, gave an average of 19,456,000 foot-pounds of work done for each 112 pounds of coal burnt in the furnaces; and by successive improvements the same number of Cornish engines (24) gave in 1856 an average duty of 47,000,000 foot-pounds. Neglecting the absurd claims made for certain Cornish engines, there are apparently trustworthy records in which more than 90,000,000 foot-pounds of work were had by an expenditure of 112 pounds of coal; but an average duty of say two-thirds of this is about all that can be safely relied upon for the best engines of this class.

THE WEAK POINTS IN TRADE-UNIONISM.

By Lawrence Irwell.

THE student of history who looks at the increasing numbers and improving organization of trade-unions will easily be convinced of the important part which they are likely to perform in the future of the United States; he will also be ready to admit that some form of united action is essential to the progress and amelioration of the wage-earning community. Indeed, the ability exhibited by what we are accustomed, very improperly, to designate the "working population"—as if brain-workers were not workingmen—in the formation and management of legitimate societies for their general welfare has already been displayed in so great a degree that it may be regarded as a proof of the capacity of the Anglo-Saxon race for all general purposes of self-government.

As the influence of unionism is daily becoming greater, it is more than ever necessary that its objects and attainments should be really liberal and that every step should be thoroughly considered before being taken. It is within the power of organized labor to do an immense amount of good or a serious amount of injury, not only to its own members, but to the country generally, and if it undertakes to effect any object outside its province, which cannot be achieved by the means at its disposal, even though the immediate results may appear satisfactory, yet eventually injuries of an extensive and widespread character are sure to ensue.

I propose to show that attempts upon the part of labor organizations to *permanently* regulate wages are, *in the majority of cases*, injurious to the best interests of the workers themselves and to the well-being of the community. Whether a man chooses to work eight hours a day or ten is a matter entirely under his own control; but whether his earnings shall be $3 or $5 a day is outside his influence, and beyond that of any combination of workers, because it depends upon circumstances which cannot be regulated by individuals, either alone or in a body. When attempts are made to secure higher wages than are produced by the natural process of supply and demand, with the addition of the skill of the worker, the outcome is in some instances utter failure, and in others a supposed success, which, when examined, shows that other workers have been deprived of a portion of the reasonable earnings to which they were justly entitled.

The science of economics is not, I presume, a favorite study of trade-unionists, but all classes of the community have of recent years been willing to pay some attention to the doctrines which it propounds. A general increase in wages depends upon the augmented productiveness of the workers, either from increased skill or from improved processes or inventions; it may also be caused by an extension of markets, by the opening up of new countries, perhaps by the discovery of gold mines,—at any rate, by a new and greater demand for the products of labor, in return for which an increased supply of food and raw materials will reach the working community.

Having stated what all recognized economists admit to be the only causes of a *general* increase in wages, I must insist at the outset that the methods of trade-unions are not of such a character as will tend to produce the desired end. Indeed, their action is often directed towards decreasing rather than towards adding to the actual product of labor.

My general assertion is that, whenever unionism succeeds in keeping up a higher rate of wages than natural laws produce, the community of consumers pays the difference, and is therefore the sufferer by the process. To the unbiased observer this system will very closely resemble that of an import tariff, which assists one class—the manufacturers—at the expense of the rest of the population.

In every case in which labor below a certain rate of remuneration is prohibited by any device, the rate is kept above what it would otherwise be by a simple system of protection. Let us imagine a case in which the workers in some factory combine to secure higher pay than before and the manufacturer, through the pressure of contracts, or for other reasons, eventually consents. The increased wages do not come out of his profits, but out of the pockets of those who purchase his goods, because he will in the end recoup himself by raising the price of what he sells; whether he does so at once or not is quite immaterial. Eventually the purchasers are indirectly taxed for this addition to the earnings of the operatives in some one establishment.

The chief process by which general prosperity can be produced is by making the necessities of life as cheap as possible and by bringing various comforts within the reach of everybody; yet members of trade-organizations frequently combine to raise their own wages and to make what they produce dearer to other workers. Could the laborers in all industries follow their example, all necessities would be dearer than they are, the cost of their production having been increased; this would mean a lessened demand, followed, of course, by a smaller output and a diminished employment of labor.

But it is not easy for all trades to combine; such work as requires special skill—say that of compositors—has far greater facilities for combination than a trade in which the manual operation is quickly learned. This fact is so obvious that it is needless to dwell upon it.

Wages are only worth what they can be exchanged for: how much their value is consists, not in the amount of gold or silver, but in the quantity of necessities that they will purchase. If, then, by a general system of unionism in every trade wages were increased,—say 5 per cent.,—an addition to prices would follow and no general advantage would be effected.

The struggles between capital and labor are not what they appear at first sight; they are conflicts between two sections of workers, and the second section, as I have shown above, very frequently constitutes the whole community of consumers. Unionists appear to think that men are producers only and that the higher prices are, the richer everybody will be. We are all consumers as well as producers, and, when cheap production is interfered with by artificial means, all of us suffer.

If there is one name which workers all over the world should honor more than that of perhaps any other man, it is the name of John Bright. In 1875 he wrote these words: "A book, not a small one, might be made up of the strange doings of trade-unions. Monopoly is hard to teach, and I fear the workingmen will only learn through suffering, and may do mischief which cannot be afterwards repaired." The unionists in the United States have learned neither by the experience in England nor by the words of Mr. Bright. Strikes for the purpose of obtaining higher wages have been numerous for some years past, and the actual loss to the country must have been enormous. So serious has the danger of a strike become that one great railroad is reported to be demanding that all those whom it employs shall either cease to be members of trade organizations or leave the company's service.

If unionists would realize the true basis upon which wages stand, this element of danger would no longer exist. I repeat that I am aware of the contempt which organized labor professes to feel towards teachers of economic science; nevertheless this must not deter me from stating the wages-fund theory as expressed very clearly by Professor Cairnes in his book, "Some Leading Principles of Political Economy." He says, "Wages-fund is a general term, used in the absence of any other more familiar, to express the aggregate of all wages at any given time in possession of the laboring population; on the proportion of this fund to the number of the laboring population depends at any given time the average rate of wages: the amount of the fund is determined by the amount of the general wealth which is applied to the direct purchase of labor, whether with a view to productive or to unproductive employment."

The actual experience of Mr. (now Lord) Brassey in reference to the question of wages is most valuable, and I therefore reproduce his words: "High wages do not necessarily imply dear labor, just as, on the other hand, low wages do not, of necessity, make labor cheap. On my father's extensive contracts, carried on in almost every part of the civilized world and in every quarter of the globe, the daily wage of the laborer was fixed at widely different rates; but it was found to be the almost invariable rule that the cost of labor was the same,—that for the same sum of money the same amount of work was everywhere performed. Superior skill, extra diligence, and a larger development of physical power will often compensate the employer who finds himself obliged to pay higher wages than his competitors."

Now what does this mean? It means that wages are a question of supply and demand, depending upon the amount of work which the ability of the laborer will enable him to perform; in addition, the demand must depend upon the prospect existing in the mind of the employer of finding a sale for whatever he may produce. As that is the primary consideration with any manufacturer in investing his capital, it must also govern his operations after he has actually commenced business. Should the demand for his goods increase, the amount of his investment will be augmented; upon the other hand, let the demand be lessened, and, in order to escape loss, he will diminish the amount of capital invested. From these arguments the conclusion is necessarily deducted that, the larger the capital invested, the greater will be the amount of wealth spent in wages, assuming, of course, that other things are equal.

Unionists, however, appear to ignore the fact that by no possibility can capital be compelled to invest more money in wages after a minimum rate of profit has been reached, and they seem to forget that the competition of different capitalists in the same branch of industry is quite as keen as the competition among workers. The effect of this competition is to bring an excessive number of competitors into the profitable branches of industry, and thus to reduce the rate of profit. If then trade-unions insist upon attempting upon a large and systematic scale to force a redistribution of wages and profits, capital will most assuredly be withdrawn and will cease to be advantageously employed. I am not saying that temporary victories may not be gained in some branches of industry. Unions have undoubtedly succeeded in embarrassing many employers, who submitted to lose their entire profits for the time being rather than to close their works; but capital is abundant, and, if it were applied freely to every kind of employment with the effect of reducing profits to a minimum, the condition of the laborer would be vastly improved by the process. Work would be more plentiful than at present, and a greater degree of national prosperity would ensue.

Nothing that has been written vitiates the conclusion that an advance in wages in certain industries may be produced by the action of unions, where an equal reduction takes place in others; this reduction may not even appear in the money payment, but it is always evident in the purchasing power. Were it possible to exclude the work of outsiders,—sometimes of foreign countries,—the advance might be permanently maintained. Even this, however, amounts only to a change in the distribution of the "wage-fund," and its total amount remains the same.

In any form of employment of productive capital there can be no ultimate object beyond that of making a profit. Let this be obstructed, and the interests of the working classes will be injured as seriously as those of the capitalists. Yet the policy of trade-unions appears to be to impede the use of capital in profit-bearing enterprises.

There is, however, a marked distinction between productive and non-productive labor which must be observed in connection with the question of wages, although it would be difficult to specify exactly where the one begins and the other ends. In the case of productive labor the capital is returned with the addition of a profit, and the entire capital remains exactly as before. In the instances of absolutely non-productive labor the capital is consumed and cannot, therefore, form any part of the future "wages-fund." But while we cannot draw any marked line between the two classes of labor, we know that capital expended in the employment of workers will in the majority of cases return to the capitalists plus a profit, and business will always be gradually extending.

Supposing, however, that the incessant pressure of trade-unions violates the general conditions previously referred to, and capital spent in the employment of labor is not restored with a profit, but with a loss, the members of the unions will feel the injury quite as soon as the employers and probably sooner. The use of capital in productive industries in which it is returned after a time with a profit will sustain the rate of wages, while that employed in the improper use of luxuries will give no return to the capital fund and will obviously have a harmful effect upon the earnings of the workers. In the former case employment will be constantly increasing, as the population grows,—a point which must never be overlooked in dealing with this somewhat complicated question.

I must express my firm conviction, with great reluctance, that it is against the reproductive use of capital that the action of the unionists is only too often directed ; if the present state of affairs continues, capital is certain to be employed in forms unproductive as far as the "wages-fund" is concerned.

Feeling, as I do, that the leaders of strikes and members of unions generally will not hesitate to condemn all I have written upon this subject, I beg to make an extract from a speech delivered by the late Richard Cobden in 1849 : "I wish to see the great mass of the working classes of this country [Great Britain] elevate themselves by increased temperance, frugality, and economy. I tell you, candidly, that no people were ever yet elevated except through their own advancing wealth, morality, and intelligence ; and any one who tells the workingmen of this country that they may be raised in the social scale by any other process than that of reformation in themselves is interested either in flattering or deceiving them." If this applied to the wage-earners of the United Kingdom in 1849, does it not apply with equal force to those of the United States in 1893 ?

It should be distinctly understood that the foregoing pages have no claim to originality or novelty. Every fact has been written before,—perhaps many times,—but an attempt has in this

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It is certain that workers can gain nothing by wasting their energy in denouncing the harshness of capitalists, while they are themselves throwing away the means by which they may become owners of capital.

The wage-earners may be as intelligent, honorable, and contented as men of any other class, and indeed many of them are. The superiority of capital over labor has very frequently had its origin in abstinence, and in the denial of present benefit for future reward.

Some three centuries ago Montaigne wrote: "I have known in my time a hundred artisans and a hundred laborers wiser and more

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instance been made to put the whole of the subject concisely and clearly in the hope that some of the leaders of the wage earning classes may have an opportunity of learning that this question, like all others, has two sides to it.

Labor cannot benefit by fighting against capital, or by antagonizing investors. Unions are most useful institutions if they aim at such reforms as are required, and if they direct their exertions towards useful objects. The tyranny of which we hear so much is not by any means the tyranny of the capitalist, but of the improvident condition in which many of us live; and as soon as we possess any savings (*i. e.*, capital), the troubles of this condition are enormously lessened.

I venture to make two very simple suggestions, but, simple as they are, they are surely worthy of some very serious attention.

I. That trade-unions should offer every inducement to their members to save money, and thus become capitalists,—in a small way, perhaps, but still capitalists in the true sense of the term. When a strike takes place, the strikers often subsist upon the contributions of other workers,—a process which deprives many non striking wage-earners of the whole, or a portion, of their savings.

II. That full liberty be left to non-union workers to take the work of those who, by a system of combination, have "struck" for higher wages, and that no obstruction be placed in their way, or in that of the employer. In a few words, let the system of "boycotting" non-unionists, with the accompanying outrages, be a thing of the past. If there must be strikes, let them be as few as possible and let them be conducted in a creditable and orderly manner.

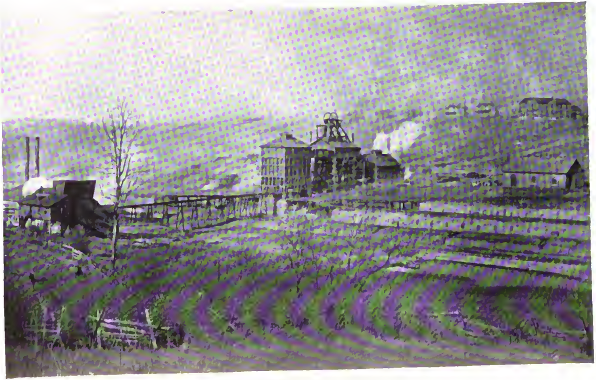
It is certain that workers can gain nothing by wasting their energy in denouncing the harshness of capitalists, while they are themselves throwing away the means by which they may become owners of capital.

The wage-earners may be as intelligent, honorable, and contented as men of any other class, and indeed many of them are. The superiority of capital over labor has very frequently had its origin in abstinence, and in the denial of present benefit for future reward.

Some three centuries ago Montaigne wrote: "I have known in my time a hundred artisans and a hundred laborers wiser and more happy than the rectors of the University, and whom I had much rather have resembled." Many of us to-day will re echo the sentiment, especially if millionaires be substituted for rectors of universities.

Capital is always ready to give employment to labor, and the wage-earners are always willing to be employed, yet the continual strikes are causing the one class to regard the other as enemies, instead of brother-workers. Surely the more intelligent unionists must be beginning to see that the heavy losses are impoverishing the very men who cause the strikes, and are subjecting the productive industries of the country to a strain of an almost intolerable character.

Let us sincerely hope that the day is approaching when reasonable demands will be conceded without strikes, and when deliberation, coupled with a free interchange of opinions, will promote confidence and mutual regard in place of animosity and distrust.



LEISENRING NO. 3 WORKS—THE H. C. FRICK COKE COMPANY.

COKE MANUFACTURE IN THE UNITED STATES.

By William Glyde Wilkins, M. Am. Soc. M. E.

THE output of pig-iron from the blast-furnaces in the United States has increased to a surprising extent since 1880. While the influence of improved forms of furnaces, hot-blast stoves, and blowing engines is to be considered, it is undoubtedly true that a very large share of the increase is due to the substitution of coke for coal as fuel. In 1875 Mr. John Fulton, in a report of the Pennsylvania State geological survey, wrote: "It is also manifest that *coke is destined to become the leading fuel for blast-furnaces, and to retain this position from its almost inexhaustible source of supply, its calorific intensity, and its continued economy.*" The italics are Mr. Fulton's. The results in present blast-furnace practice have more than justified his prophecy. Previous to the year last named the amount of anthracite coal used to produce one ton of pig-iron was 1.85 tons. Now, in the Pittsburgh district, where there are twenty-three blast-furnaces, the yield of pig-iron is one ton to one ton of coke, while furnace "F," at the Edgar Thomson steel-works, has used as low as 1845 pounds of coke to produce one ton of iron. Stimulated by the demands of the furnace men, the manufacture of coke in the United States has increased to a very large extent. In 1891 the coke industry was in progress in no less than twenty States, requiring 40,245 ovens. The output of coke for that year, according to the special report prepared by Mr. Joseph D. Weeks for the United States census, was 10,352,688 tons.

The manufacture of coke on a large scale in the United States was first started in the Connellsville region, in Pennsylvania, and a reference to the report by Mr. Weeks will show that this State still holds the lead in the number of ovens and extent of output. It is conceded by blast-furnace operators that the Connellsville product gives better results than any other coke made in the United States, and it is shipped to all parts of the country to which freight rates are not so high as to prohibit its use. The Connellsville practice has become the standard both for method of construction of plants and manner of operation, and hardly a day passes that persons interested in the manufacture of coke in other parts of the Union do not visit this region for purposes of investigation. The writer believes therefore that a description of methods in this region will give what may be considered to be the standard practice in the United States.

The Connellsville coke region is situated in Fayette and Westmoreland counties, Pennsylvania. According to a recent topographical survey made by Kenneth Allen, M. Am. Soc. C. E., for the H. C. Frick Coke Company, the basin has a length of 43.6

COAL-MINER AT WORK.

PLANT NO. 2—HECLA COKE COMPANY, LIMITED.

miles, and an average width of 3.1 miles, or an area of 137 square miles. The region takes its name from the town of Connellsville, in the center of the basin, near which the manufacture of coke was begun. A history of the region would be practically a history of the H. C. Frick Coke Company, who own and control 9096 of the 17,315 ovens in the basin, or considerably more than half the entire number. The McClure Coke Company rank second, having 2905 ovens, and W. J. Rainey third, with 1400. There are eighty-four mines and coke plants in the district, the plants ranging in size from 39 to 905 ovens, the later being the Standard plant near Mount Pleasant.

A recent writer in the Connellsville *Courier* says: "The first coke made in this region was made in 1841, by McCormick, Campbell, and Taylor, in two ovens, built near the mouth of Hickman run. These two ovens were built from a description given them by an Englishman of the ovens in Durham, England. The makers had hard work to dispose of their product at eight cents per bushel, and retired from the business in disgust. However, James Cochran and others saw an opportunity in the business, and leased the plant, and in 1842 they sold in Cincinnati 13,000 bushels at seven cents. James Cochran continued in the business, and is to-day part owner in three plants, of 750 ovens." From this small beginning has grown a business that in 1891 amounted to an output of nearly 5,000,000 tons, or nearly one-half the product of the United States, giving direct employment to about 18,000 men. The increase in the number of ovens, since 1860, is thus shown:

1860	30 ovens.	1887	12,561 ovens.
1872	3.673 ovens.	1888	13.113 ovens.
1880	6.237 ovens.	1889	14.458 ovens.
1882	8,400 ovens.	1890	16,020 ovens.
1884	10.000 ovens.	1891	17.204 ovens.
1886	10,854 ovens.	1892	17,315 ovens.

Geologically speaking, the coal belongs to the Pittsburgh vein, but it is not connected directly with that vein in the neighborhood of Pittsburgh. It is much softer than the coal mined about Pittsburgh, and in mining breaks up quite small, and the run of mine

COAL-WASHER, SLOPE NO. 2, PRATT MINES.

VENTILATING FAN AT FRICK'S ADELAIDE WORKS.

coal has a very large percentage of slack. In the Connellsville region the entire output of the mines is coked. On account of its fineness it does not need crushing, and its purity makes washing unnecessary. For these reasons it is cheaper to coke than other coals which are harder and less pure, and which have to be both crushed and washed. The great point in its favor above all other cokes, and which is recognized by iron-manufacturers, is its hardness or ability to sustain the burden of the ore and limestone in the blast-furnace. Below is given a table showing a comparison of analyses of the Connellsville and other cokes:

ANALYSES OF COKE.

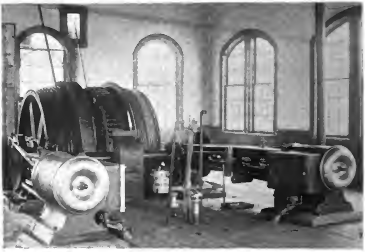
[From report of John R. Procter, Kentucky Geological Survey.]

WHERE MADE.	Fixed Carbon.	Ash.	Sulphur.
Connellsville, Pa. (Average of 3 samples)........	88.96	9.74	0.810
Chattanooga, Tenn. (Average of 4 samples).......	80.51	16.34	1.595
Birmingham, Ala. (Average of 4 samples)........	87.29	10.54	1.195
Pocahontas, W. Va. (Average of 3 samples).......	92.53	5.74	0.597
New River, W. Va. (Average of 8 samples).... .	92.38	7.21	0.562
Big Stone Gap, Ky. (Average of 7 samples)... ...	93.23	5.69	0.749

Twenty-one of the eighty-four mines have shafts, ranging from 50 feet deep, at the Adelaide works, to 541 feet, at the Leisenring

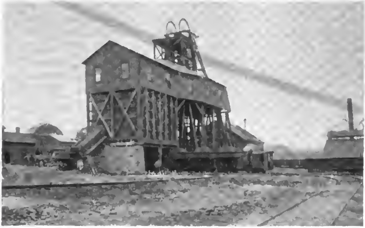
No. 3 works. The others are slope or drift mines. There has been much discussion as to the comparative advantages of shafts and drift or slope mines. The majority of engineers and operators in the Connellsville region seem to favor the shaft. However, in opening up the mines this discussion does not appear to have been a factor, as local considerations have almost entirely determined the method in each case. In starting a new plant, proximity to some railway has generally influenced the location of the surface works. It is the general opinion, however, that in shaft mines the coal is in the long run mined more cheaply than in drift or slope mines.

The vein of coal is from seven to nine feet thick,—averaging about eight feet,—and will yield about 8000 tons of coal to the acre. A reference to the columnar section of Leisenring No. 3, the deepest shaft in the region, will show the strata and coal veins. The nine-foot vein is the only one mined, except at one or two mines, where slopes or drifts have been driven into the five-foot vein.



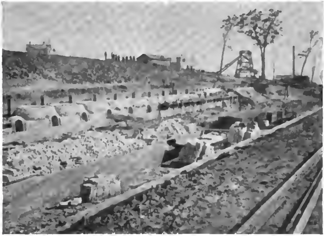
HOISTING ENGINE IN A COKE-PLANT.

The usual method of mining is the pillar and room system, with from one- to five-main entries At the Oliver mines, near Uniontown, the coal is being taken out on the five-main entry system, this being the only mine in the country where this is done. Some advantages claimed are: ventilation without the use of



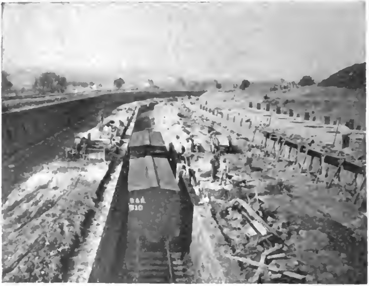
PLANT NO. 1—OLIVER COKE AND FURNACE COMPANY.
[First steel head frame designed in the Connellsville region.]

doors; separate intakes and outtakes for each district; a great reduction in number of stoppings; the passing of intake air-currents to extreme end of main headings, without passing old workings; the division of the air-current so as to more easily and safely regulate the velocity; all return air-currents may be through disused headings, and the hauling roads and traveling ways may be intakes.



COKE-PLANT IN COURSE OF CONSTRUCTION.

In slope and drift mines the pit cars are hauled up an incline to the top of the coal-bin, from which the larry wagons are loaded. In shaft mines the pit-cars are in most works pushed from the cage by hand at the upper landing and dumped into the bin by hand. At some mines this is done by "Ramsey's patent caging apparatus," which pushes the loaded car off the cage, and an empty car on, at one operation. After the coal is dumped, the car runs by gravity to the back of the cage and is then ready to push the next load off. At other mines the self-dumping cage is used. With this method the car does not leave the cage, but the coal is dumped automatically to the bin with a saving of the labor of one to three men.



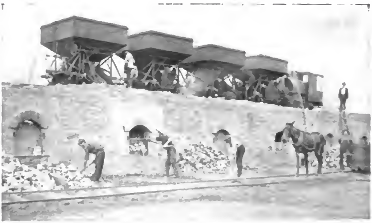
COKE OVEN PLANT.
[Showing double block complete; bank ovens partially built.]

The coal is taken from the bottom of the bins into the larry wagons, and from these dumped into the coke-ovens. Mules are still used to move the larry wagons at the smaller plants, but small locomotives, weighing about 6½ tons, are more generally used, hauling four larries at a trip. At some of the works a wire-rope haulage, extending from under the bin to the lower end of the ovens, is used to draw the larries. Wire-rope haulages are also largely used in the mines in the main headings. The cars are hauled by mules from the rooms to the main headings, where "trips" of as many as twenty cars are hauled to the tipple or to the bottom of the shaft.

The Connellsville ovens are of what is known as the "Bee-hive" type, and are from 10½ to 12½ feet in diameter, and from 6 to 8 feet high. The charge for each oven is from 110 to 190 bushels of coal, and the yield of coke per oven drawn is from 3 to 4½ tons of coke. The majority of the product is 48-hour coke, this being the length of time for the coking process before the charge is drawn. The Friday and Saturday charge, however, is not drawn until Monday, making what is called 72-hour coke. This is known as foundry coke, and is preferred in foundry work.

NO. 2 OVENS, PRATT MINES, ALABAMA.

Crushed coke is now being introduced into the eastern part of the United States in competition with anthracite coal for domestic use. There are much less gas and bad odors from it than from the hard coal. It is also being used in locomotives on the fast passenger trains of the Baltimore and Ohio railroad between New York and Washington. It will probably be used very largely in the future in Pittsburgh, now that natural gas is becoming scarce as its freedom from dirt and small amount of ash, as compared with the bituminous coal formerly used before the days of natural gas, make it preferable.



DRAWING COKE FROM OVENS

When the coal is first dumped into the oven, it is levelled down to a uniform thickness, and the door is bricked up and daubed with loam, leaving no opening, except about two inches at the top, the full width of the door. The heat in the bricks of the oven, after the preceding charge, soon ignites the gases at the top, and the draft is regulated by bricking up or taking out bricks, so as to properly coke the coal without consuming it. After the proper time has elapsed, the coke in the oven is cooled off by drenching it with water. The coke is then drawn out of the oven to the yard in front and further watered, so as to cool it sufficiently to prevent setting on fire the railway cars in which it is loaded. The coke is wheeled into the cars, which contain from 30,000 to 50,000 pounds each. The Frick coke company are now experimenting with a mechanical coke-drawer which, it is said, will draw forty ovens per day and with one man will do what is now done by fifteen men.

The amount of water required to cool one oven of coke is 600 gallons, so that, when all the ovens in the region are in blast, one-half being drawn each day, there is a daily consumption of water for this purpose alone of about 5,200,000 gallons. This amount of water would supply a town of 52,000 inhabitants with 100 gallons daily, per capita. Taking into account the uses for boilers, domestic supply, etc., it is probable that double this amount is used. Most of the works get their water-supply from small mountain streams, which in summer time are very scanty, and it is often absolutely necessary to use mine water for washing the coke. This water is very strongly impregnated with sulphur, more or less of which is of course imparted to the coke. It will thus be seen that the question of a pure water supply is a very serious one for the region. In order to be certain of an unfailing supply the Oliver coke works obtain their water from the Youghiogheny river, at a distance of eleven miles. The water is pumped through eight-inch pipe that formerly supplied Uniontown with natural gas, this being the first instance of a natural-gas line being transformed into a water line.

The buildings, head frame, etc., about the shaft were formerly built of wood and in the cheapest manner possible. The numerous losses by fire have impressed on the larger operators the necessity for better construction, and brick or iron buildings, and iron and steel head-frames, are now built. It is probable that in all future plants iron and steel will be the material used.

In building a coke-plant experience has shown that for every coke oven the company should have about thirty acres of coal. Besides the ovens, the plant will have to be provided with the proper hoisting engines, boilers, buildings for same, locomotives, tools, etc. Most plants have also a number of dwellings, which are rented to the workmen at reasonable rates, as it is better to have the men live near the works. The houses for miners and coke-workers are generally double houses, having in each half four rooms, well plastered and substantially built. Each tenant has a

TENEMENT-HOUSES AT TROTTER WORKS (FRICK COMPANY).

lot 50 by 100 feet, and many of them transform this ground into vegetable- and flower-gardens.

As to the cost of building a coke plant, the writer can say from his experience as a constructing engineer that a 300-oven plant, substantially built, with the necessary machinery, buildings, railway tracks, and houses for the miners, exclusive of the shaft or slope, can be erected for $200,000, or say $700 per oven. If a shaft is sunk, there should be added to this $100 for each foot of shaft, to 300 feet deep, and $125 for each additional foot. The cost per oven, including grading, masonry, oven brick, and railroad tracks, or all items chargeable to oven construction, is about $325 per oven. These figures are exclusive of cost of coal-lands.

The laborers in the Connellsville region are mostly immigrants of the most degraded and ignorant classes, the Hungarians predominating. They were first brought into the region to take the place of strikers, but it did not take them long to get sufficiently Americanized to begin striking on their own account. In 1891 the scale under which they were working expired, and 16,000 workers went out on a demand for an advance in wages amounting to about 12½ per cent. Their demand was not granted, and the refusal was the excuse for outrages of the most violent character. Works were set on fire, buildings wrecked, men who wanted to work were mobbed, and the entire region was in a state of uproar. The sheriffs not being able to maintain order, the governor called out the State troops, and in a conflict between the strikers and troops at the Moorewood works a number of persons were killed. After fourteen weeks of idleness the strikers returned to work at prices dictated by the employers, and there has been no further outbreak.

The Connellsville region has been the scene of many accidents and great loss of life. On June 6, 1890, a fire broke out in the Hill Farm mine, causing the death of thirty-one miners and entailing great loss on the mine-owners. A bore hole had been put down from the surface, and, when this hole was opened in the mine, a large amount of water rushed in. The noise of the rushing water alarmed a miner, and he ran frightened along a heading with a naked light. As he passed the bore hole his lamp ignited a gas-feeder. In a few moments the whole slope was on fire, and it was twenty-two months before the water was pumped out and the last of the bodies recovered.

Six months later an explosion occurred at the Mammoth mine, which was the most disastrous accident, counting the loss of life, that ever occurred in Pennsylvania. It occurred from an explosion of gas intensified by fine coal dust, and fully 75 per cent. of the 109 men killed were smothered by after-damp.

Since these accidents it has become almost the universal custom not to allow the miners to use naked lights, and all are furnished by the mine-owners with safety-lamps. Quite a number of mines now light the shaft bottom, pump room, and stables with incandescent electric lights. As a rule the owners of the mines do all in their power to prevent accidents, as a matter of good business policy, as well as from motives of humanity. There are, however, some owners too parsimonious to take precautions that they are not forced by law to do. There is now before the State legislature a proposed new mine law for the bituminous regions, the purpose of which is to compel mine-owners to take all precautions possible for the protection, not only of life, but of their own property as well.

In Fayette and Westmoreland counties there are quite a number of plants outside of the Connellsville district making coke from the Pittsburgh vein. Coke is also manufactured to some extent in fourteen other counties in Pennsylvania.

No attempt is made to save any of the by-products, such as tar and ammonia. Some experiments have been made in this country with different forms of patent ovens, but they have so far proved unsatisfactory. One great objection to any of these forms is their great cost as compared with the "bee-hive." It has always been a question with coke manufacturers whether the revenues derived from the by-products would give a sufficient return for this increased investment. The fact that there have been no plants built in this country for the purpose of saving these by-products shows that the owners thus far have answered this question in the negative.

Alabama ranks next to Pennsylvania in the production of coke, the yield in 1891 being 12.39 per cent. of the entire output of the United States. In 1880 this State stood sixth in the list, producing only 1.53 per cent. of the total for this country. This great advance has been in connection with the great development in the iron industry in the neighborhood of Birmingham. The yield in 1891 was 1,282,496 tons, from 5068 ovens. Of this number 4431 ovens are in the Warrior District, 567 in the Cahaba, and 70 in the Coosa district.

The coal-fields of Alabama aggregate nearly 8700 square miles, of which 7810 are drained by the Warrior river and tributaries and by the Tennessee river, and are called the Warrior district. It comprises all that field northwest of the Alabama Great Southern railroad. The next largest district, southeast of the Warrior, is drained by the Cahaba river, and contains 435 square miles. The Coosa district, containing 415 square miles, is drained by the river of the same name. Mr. Henry McCalley, the assistant State Geologist, says that the Warrior field alone contains three times as much coal as the bituminous and semi-bituminous fields of Pennsylvania.

The largest coke-producers in Alabama are the Tennessee Coal and Iron Company, whose various plants include the following ovens:

	Ovens.
Pratt Mines Division—Plants No. 1, No. 2, No. 3, and No. 4. (Six miles from Birmingham)	808
Cahaba Division—Blocton	467
De Bardeleben Division—Bessemer, Blue Creek, and Helena	1,120
Birmingham Division—Alice furnace	250
Total ovens of this Company in Alabama	2,645

The coke is made from coal mined in the Pratt seam, and the analysis is about the same as Connellsville coke, with the exception of the ash and sulphur, which are somewhat higher.* About one-third of the coal coked at Pratt mines plants No. 3 and No. 4 is crushed and washed in a "Robinson" washer, as is also the case at No. 2. Both washers have proved satisfactory, and the coke is improved in quality, and Mr. Erskine Ramsey, M. E., of this company, is of the opinion that it will not be long before all coke made in this State will be from washed coal. At plant No. 2 the waste heat from a battery of twenty-five ovens is used to run two batteries of boilers, which furnish the steam to operate the machinery at shaft No. 1. This has proved so satisfactory that another boiler-plant to be operated in the same manner is now being erected.

This company also own five plants in Tennessee, having 638 ovens. The total number of ovens operated by them is 3283, making them rank second as coke-operators in the United States.

The manufacture of coke in West Virginia was first begun in the Kanawha district in 1878. There are now in that district 474 ovens. There are in New River 787 ovens, in Flat Top 1889, in the Northern district 1081, and in the Upper Potomac 390 ovens. The Flat Top field, in which the first ovens were built in 1886, is considered by many to be the most promising in the country, next to the Connellsville region. It has been made the subject of an interesting special report for the eleventh United States census by Mr. Joseph D. Weeks.

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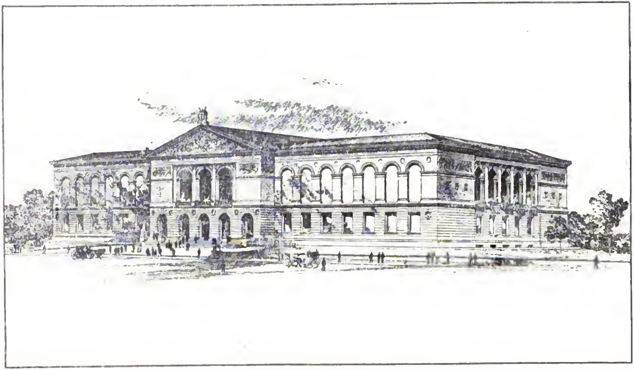
* A more complete account of Alabama coal and coke may be found in the Transactions of the American Institute of Mining Engineers, Vols. XVII and XIX.

The coal-lands in this field are owned or controlled by either the Flat Top Coal Land Association or the Crozier Land Company. The coal is mined on a royalty, and all lessees are required to sell their output through the Pocahontas Coal Company. The coke is sold through the Hull Coal and Coke Company. In this field only slack is coked. The yield of coke is generally put at 62½ per cent., but operators admit that it runs as low as 53 per cent. Over half the coal coked in this State is washed before coking.

Tennessee ranks fourth as a coke-producing State, the output in 1891 being 3.52 per cent. of the entire amount. The coal-fields are an extension of the bituminous fields of western Pennsylvania and West Virginia, covering an area of more than 5000 square miles. The seams from which coke is made are from three to five feet in thickness, and generally variable. Most of the coke is made near and used in the blast-furnaces of the Chattanooga district, and contains from 16 to 23 per cent. of ash. It is also higher in sulphur than the Connellsville coke. The amount of coke used in the blast-furnaces in this district is about two tons to one ton of iron, but, as the coal is plenty and cheap and cost of transportation small, iron-manufacturers are satisfied to use this quality of coke rather than pay a higher price for a better grade.

While Tennessee is fourth in rank, it produced in 1891 but 364,318 tons, as against 4,760,665 tons in the Connellsville region. None of the other sixteen States produced over 40,000 tons, except Virginia, Georgia, and Colorado.



THE ART INSTITUTE OF CHICAGO.

[The International Engineering Congress will be held in this building.]

THE WORLD'S FAIR INTERNATIONAL ENGINEERING CONGRESS.

By J. K. Freitag.

"It is the glory of Engineering in its supreme purpose to apply the materials and forces of nature to the service of man, and make him master of land and sea."

TO the Western Society of Engineers belongs the credit of having inaugurated, in connection with the World's Columbian Exposition, a movement of the greatest importance to the science of Engineering,—a movement contemporaneous with activity in every branch of thought, which has resulted in a series of international congresses, already so successfully begun by the Woman's Congress and followed by others up to the present date. These congresses will be in session during the entire six months of the Exposition, and will deal with every subject pertaining to the intellectual, moral, and spiritual advancement of man.

The World's Congress Auxiliary, with Charles C. Bonney as president, is an organization authorized by the directory of the Exposition, and recognized and approved by the United States Congress, to have charge of and conduct all conventions relating to human progress, with the assistance and coöperation of the leaders in every branch of thought. Thus while the Exposition proper deals with things, or the *material* presentation of human achievement, the Congress Auxiliary endeavors to portray intellect, the scientific and moral principles underlying material accomplishments, or, as the motto of the Auxiliary defines it, "Not things, but men." It is the first time in the history of the world that one organization has attempted to bring into the connected and harmonious relations of a whole all the distinct branches of human progress.

The results of these congresses will be the expounding of the best principles and methods of promoting the advancement, welfare, and happiness of the human race, and the effectual accomplishment of these methods by the formation of international brotherhoods whose efforts will keep the whole world abreast the onward strides of thought and civilization. There will be nineteen departments in this congressional work, convening in the following order:

May. I. Woman's Progress.
II. The Public Press.
III. Medicine and Surgery.
June. IV. Temperance.
V. Moral and Social Reform.
VI. Commerce and Finance.
July. VII. Music.
VIII. Literature.
IX. Education.
Aug. X. Engineering.
XI. Art and Architecture.
XII. Government, Law Reform, Political Science.
XIII. General Department.
XIV. Science and Philosophy.
Sept. XV. Labor.
XVI. Religion, Missions, and Church Societies.
Oct. XVII. Sunday Rest.
XVIII. Public Health.
XIX. Agriculture.

When the idea of a series of world's congresses was first advanced, the president of the World's Columbian Exposition appointed a preliminary committee to investigate the scope of such congresses. It soon became apparent that the extent of such an undertaking was far beyond the reach of a single committee, and that an auxiliary organization must be formed. Therefore the World's Congress Auxiliary of the World's Columbian Exposition was organized on October 30, 1890, and full authority given to it to execute arrangements for the world's congresses of 1893. It was decided that the affairs of each congress were to be conducted by a committee, the members of which were to be chosen from Chicago and its vicinity, in order that they might be able conveniently to carry on all the local arrangements for the congress. These committees have had charge of correspondence to interest kindred associations in the work of the various departments. They are assisted by an advisory council composed of non-residents in the United States and foreign countries who assist the local committee as freely as possible by individual correspondence, and aid in the selection of topics and of persons eminent in the various branches of the congressional work. An honorary membership has also been formed, as a general advisory council in the congressional work at large. In order to procure the most comprehensive and effectual results, the various existing societies and institutions were requested to appoint committees of coöperation to assist the Auxiliary proper in arranging for their own special departments.

The importance of the World's Congress was recognized by the government of the United States, which took active measures to gain the interest and coöperation of foreign countries in this work, as well as in the material exposition. The original announcement of the World's Congress Auxiliary was sent to all countries of the world accompanied by the invitation of the president of the United States to take part in the Exposition of 1893; and to all the diplomatic and consular officers of the United States was sent a circular asking them to invite the respective governments to which they were accredited to send a convenient number of the most eminent representatives of the various departments of human progress, as delegates to attend the congresses, in addition to those who would come from abroad as representatives of leading institutions and societies. It was requested that these delegates be permitted to attend all the congresses held from May to October, in order that, by the coöperation of every existing government, there might be ascertained the state of human progress in every department up to the year 1893; that the living problems which remain unsolved might be clearly set forth, and the methods of their solution be arbitrated upon, thus promoting fraternal relations and the highest mutual benefits. In reply to the invitations of the government, the most encouraging and interested responses were received from all parts of the world, and now the one original committee has ramified into more than 200 committees, of which the aggregate membership is over 1600 persons. The honorary and advisory members are more than 10,000 persons from the various countries represented.

The proceedings of these congresses in all probability will be printed by the United States government for distribution among foreign governments and their institutions and libraries, as a lasting return for their part in the World's Columbian Exposition.

The congresses are now being held in the permanent Memorial Art Palace, which has just been completed on the Lake Front Park in Chicago at an expense of $800,000, through the joint efforts of the Art Institute of Chicago, the City of Chicago, and the directory of the Exposition. The Art Palace has two large audience-halls seating some 3000 persons each, and more than thirty smaller rooms seating from 300 to 700 persons each. The main halls are being used for meetings that attract large popular audiences, while the discussions of special subjects go on at the same time in the smaller rooms.

At the time when the question of the site for a World's Exposition in 1893 was first being agitated, a committee of civil and mechanical engineers, with Mr. E. L. Corthell, past president of the Western Society of Engineers, as chairman, was appointed to further the interests of Chicago as a suitable place for such a fair. At the same time the idea was presented by Mr. Corthell of making this an opportunity for holding an international congress of engineers. A circular to this effect was, therefore, sent out as early as October 7, 1889, to all of our national and local societies. Encouraging answers were received in regard to both projects. At a special meeting of the Western Society of Engineers, in the spring of 1890, after the Exposition had been authorized by the United States Congress on April 25, it was decided to take the initiative steps for such a gathering of engineers. The American Societies of Civil, Mechanical, Mining, and Electrical Engineers, and the Canadian Society of Civil Engineers, were each requested to appoint a committee of not more than five members, two of whom were to be residents of Chicago; these delegates to meet at a convention in the fall of 1890, with a committee composed of seven members of the Western Society of Engineers, to formulate the plans of the congress. All local societies of the United States and Canada were requested to send committees of three to this convention. At the meeting of this convention on October 14–15, 1890, headquarters were established, and a permanent committee was agreed upon composed of three members of the Western Society of Engineers, two members each from the American Societies of Civil, Mechanical, Mining, and Electrical Engineers and the Canadian Society of Civil Engineers, and one member each from the other participating societies. This general committee met in May, 1891, and was addressed by Mr. C. C. Bonney, of the World's Congress Auxiliary.

An extended European tour on the part of Mr. Corthell during the summer of 1891 was the means of personally interesting many of the most prominent engineers of Great Britain, France, Germany, Holland, and Belgium, and in accordance with authority from the general committee he extended a preliminary invitation to some forty engineering organizations. The greatest interest was everywhere manifested in the proposed congress, both at home and abroad.

It was at first agreed that the subject of engineering should form simply a subdivision under the department of Science and Philosophy. But, on account of the recognized importance of the profession of engineering in the world, it was made a department by itself, with seven subdivisions as follows:

Division A: Civil Engineering, in charge of the American Society of Civil Engineers.
Division B: Mechanical Engineering, in charge of the American Society of Mechanical Engineers.
Division C: Mining Engineering, in charge of the American Institute of Mining Engineers.
Division D: Metallurgical Engineering, in charge of the American Institute of Mining Engineers.
Division E: Engineering Education, in charge of Prof. I. O. Baker, of the University of Illinois.
Division F: Military Engineering, in charge of Major Clifton Comly, United States Army.
Division G: Marine Engineering and Naval Architecture, in charge of Commodore George W. Melville, Engineer in Chief, United States Navy.

The Engineering Congress will convene on July 31 and continue until August 5. It will be opened by a general session, followed by the various divisional sessions under the officers in charge, and close with a general session. There may also be joint sessions of two or more divisions on subjects of common interest; and the three national societies of the United States will make this congress the occasion of holding their annual meetings.

Invitations to participate in the Engineering Congress have been sent to all prominent foreign and American societies, institutes, colleges and schools of engineering, as well as to distinguished engineers in all parts of the world. Correspondence has been established with seventy-five societies in twenty-seven countries. This large foreign representation insures the international character of the movement, and, as this is the first international engineering congress in the history of the world, the result will be without doubt a successful representation of subjects of living interest to every engineer. There will be original papers and discussions by leaders in the profession in every branch, describing new processes, inventions, works recently constructed or in the process of construction,—in short, the advancement of engineering in the nineteenth century. A complete list of the papers cannot yet be given, but among the more interesting of those promised the following may be mentioned :

Railways of the Far West, by V. G. Bogue.

Development of the Water Power of Niagara Falls, by John Bogart.

The Treatment of Metals for Structural Purposes, by James Christie.

Drainage and Sewerage of the City of Mexico, by Roberto Gayol, City Engineer of the City of Mexico.

Drainage of Chicago, by F. Benezette Williams.

Superstructure of Memphis Bridge, by George S. Morison.

Some Public Works of Russia, by T. Shmeleft, of Revel, Russia, one of the Public Counsellors.

International Navigation, by P. Caland—The Hague, Holland.

The Improvements of the Harbors of the Atlantic Coast, by Captain W. W. Black, United States Engineers.

Carbon, and its use in Electrical Engineering, by Clarence Barber, Cleveland, Ohio.

Four papers are promised from members of the United States Coast Survey, five from the Society of Engineers of Lisbon, Portugal, and many others from Germany, France, Austria, Holland, Italy, and South America.

In marine engineering such topics as the following have already been chosen : " Fast Trans-Atlantic Steamers," " Forced Draught," " Resistance of Ships," " Use of Oil at Sea," " Torpedo Boats," " New Battle Ships and Cruisers of the United States Navy," and many others, by the leading practical experts of the world in marine engineering and naval architecture.

In engineering education papers are expected from many eminent educators, among others : Professor Palmer C. Ricketts, Rensselaer Polytechnic Institute ; Professors George F. Swain and A. E. Burton, Massachusetts Institute of Technology ; Professors H. S. Carhart and M. E. Cooley, University of Michigan ; Mr. A. M. Wellington, of the *Engineering News* (New York) ; Professor Unwin, of London ; and Professor Armstrong, of Edinburgh.

Such names as the following can also be given as an indication of the high standard of the valuable technical literature to be contributed : J. G. Magnagli, Rear-Admiral Italian Navy ; Walter E. Lilly, of Trinity College, Dublin ; Percy Waldram, of the Engineers' Society of London ; The City Engineer of Messina, Italy ; Captain Fred. A. Mahan, United States Lighthouse Board ; and H. D. Hoskold, Inspector General of the Mines of the Argentine Republic.

The proceedings will consist of the papers prepared in advance and accepted by the management of the separate divisions. A very large number of papers have already been secured and printed, and sent out for general written discussions. The papers will not all be read at length at the sessions, but brief abstracts only will be given, while some will be read simply by title. Then will follow the discussions, all of which have been prepared in advance. Such papers as are written in foreign languages are being translated by volunteers from the various societies, in order that correct technical interpretations may be obtained. Arrangements have been made for the printing of the entire proceedings of this congress, in a series of eight or ten volumes, thus presenting in compact form a valuable compendium of engineering literature. The various American societies have taken steps to defray the printing expenses of the papers in their own departments, while the department of marine engineering, having no national society to draw upon for funds, has succeeded in obtaining the coöperation of Messrs. John Wiley & Sons, of New York, for the publication of both the papers for advance discussion and the bound proceedings. It is expected that the papers of the Divisions of Military Engineering and Engineering Education will also be printed. Electrical Engineering, which was originally a department in the Engineering Congress, has been made, on account of its close connection with electrical science, a part of the Electrical Congress.

At the same time with the Engineering Congress, an international conference on aërial navigation will be held. The practical and partially successful experiments that have been made in the past few years on this still rudimentary subject have awakened the interest of the scientific and engineering world. Such names as Elisha Gray, H. S. Carhart, I. O. Baker, and E. L. Corthell and others as a committee, and Octave Chanute as chairman, insure a scientific and practicable treatment of a subject which for years has chiefly attracted only visionary inventors. The papers and discussions, all of which will be prepared beforehand and approved by the committee, will deal with the scientific problems involved,—aviation, ballooning, mechanical difficulties, etc. They will summarize the latest researches, and call for an exchange of ideas and concentration of action among men at work on this subject.

Another congress which will be held at the same time and which will be of special importance to engineers is the Water Commerce Congress. This is one of direct international importance, dealing as it does with that great economic question, the cost of transportation between States and nations. The cheapness of water transportation, as compared to that by rail, accounts for the steady increase of the former. In 1890 the entire cost of lake transportation in the United States was something over $23,000,000, while the cost of the same freight by rail would have been over $143,000,000. The subjects of this meeting will include building of canals, deepening of rivers, excavation of harbors, building of docks, improvements in steamers, proposed canals in the United States, and all relative topics, the discussions to be confined to the economic feature of water commerce. The executive officer of this congress is Professor William Watson, of Boston.

The Congress of Art and Architecture will very fittingly convene in the same week with the Engineering Congress.

Special efforts have been made to afford visiting engineers every opportunity to examine American works of engineering. A complete list of such works of note has been obtained from some 200 cities in the United States, and letters of introduction to any of these cities may be obtained from headquarters.

The local committee is entitled to the greatest praise for the ample and satisfactory provisions made for the reception and entertainment of visiting engineers. It became evident at a very early stage that some headquarters must be provided, both in the city of Chicago and at the Fair Grounds, where the engineers attending the Congress and Exposition could meet during social hours and obtain any desired information. To this end funds were raised, and accommodations were secured at No. 10 Van Buren street, in the city, and at the Fair Grounds in the Mines and Mining building. A staff representing the engineering societies is being maintained at these points, with stenographers, interpreters, etc. Visiting engineers will be received, given such information as they desire, made acquainted with one another, and in fact given a cordial reception in engineering circles in Chicago. The thorough and energetic manner in which the work of this congress has been undertaken and executed insures not only a series of meetings of the most vital interest and importance to participating engineers, but an ultimate crowning success in the form of a compilation of the latest and soundest engineering literature, which will be used for instruction and reference for many years to come.

STEAM LOCOMOTION ON COMMON ROADS.

By William Fletcher, M. E.

THE progress made in steam locomotion on common roads in England during the last few years has been very marked; the traction engine is rapidly supplanting the portable engine for driving threshing and food-preparing machinery, and for drawing the apparatus behind it from farm to farm. A large number of road locomotives of another type are specially built for drawing heavy loads at slow speeds, and employed exclusively for this work. The trade in this line of business for some time past has been particularly brisk, the orders mostly emanating from customers in Great Britain. Some firms are also shipping a considerable number of engines to the colonies and other parts of the world, most of the exported engines being of the slow moving class.

For the present we are not concerned with these slow-moving and ponderous road locomotives, but we purpose to consider another type of engine specially constructed for running at high speeds with light loads on ordinary highways. These quick-speed road locomotives would have been largely employed in England, if the legislative authority had not stepped in just as success was about to be realized, and, by a series of iniquitous laws, crushed this important industry in the bud. A certain class of influential people in England have a great objection to the employment on highways of any power except that of animals, and in their crusade against steam on the highway they have succeeded in curtailing the rights of traction-engine owners. Should these unfortunate proprietors of machinery happen to offend these fussy dignitaries, or frighten the wild creatures harnessed for their pleasure, they may expect to be treated with as little mercy as highway-robbers or sheep-stealers.

Some of the laws in force could be observed if a little care were bestowed by the drivers of the steam-engines
enactment that no locomotive shall travel at the rate
four miles an hour in the open country, and two
towns, precludes the employment of the conv
sidering. However, it is hoped that thes

amended or repealed, and in the meantime high-speed road locomotives are used with some success in the colonies and other districts, where no such *useless* restrictions are in force. We say useless, because it is well known that these engines are now far more easily managed than many horses, as they can be run up or down hill at speeds of seven to ten miles an hour with safety. The drivers have the engines under perfect control, steering and maneuvring them in crowded places; they can stop them on the steepest inclines, and the traveling speed, if necessary, can be reduced when passing through towns. In many countries the want of such an engine already exists, and, if one can be introduced which is satisfactory in working, and economical in fuel and repairs, it will be sure of a market.

The very early history of steam on common roads will be briefly dealt with here.* It is generally understood that Cugnot, in France, made the first road locomotive that actually carried passengers. Murdock, Symington, and Trevithick in England, and Oliver Evans in America, made very creditable steam road-engines. The first two inventors made models only, but, when Trevithick approached the steam-carriage enterprise, rapid progress was at once apparent. Omitting the names of many steam-carriage promoters whose works are interesting, we may glance hastily at some of the more recent and fairly successful steam-carriages, in order to ascertain, if possible, why complete success was not achieved.

Hancock takes a foremost place among the steam-carriage pioneers. He made more coaches than any of his predecessors or contemporaries, and he ran some of them for months with great regularity through the crowded thoroughfares of London. Most of his later carriages were built on similar lines, the machinery displaying a large amount of ingenuity and engineering knowledge. The chief feature of the machine was Hancock's patent boiler, which worked admirably. The boiler was placed at the back of the coach. The engine was of the two cylinder direct-acting inverted type. The motion was communicated from the engine crank-shaft to the main axle by means of two strong pitch chains, and, as the chain wheels were very nearly on the same level, the springs of the carriage could act perfectly without interfering with the driving motion. One or both driving-wheels could be disconnected from the axle for turning corners when traveling, or running the engine for working the feed-pump alone, or driving the fan for urging the fire. The waste steam was blown into a box for preventing noise before it was allowed to enter the chimney, and coke was used so as to avoid smoke. Thus there was no smoke, no steam, and an absence of noise from the exhaust or the machinery. The working parts were also out of sight, and these carriages caused very little annoyance to the public. A steam-pressure of 100 pounds per square inch was carried by the little boiler, and the traveling speed attained was from ten to fourteen miles an hour.

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* Fuller information on the subject may be found in "The History and Development of Steam Locomotion on Common Roads," by W. Fletcher. New York: Spon.

Hancock was a very modest man. His steam-coaches were tested very severely, and found far more successful than Gurney's, Maceroni's, Dance's, Ogles's, or those of other contemporaries, who boasted much and accomplished little. J. Scott Russell, the well-known designer and builder of the *Great Eastern*, made some coaches which were cleverly worked out. A contemporary, writing on Mr. Russell's death, which occurred as recently as 1882, said: "The springs of his steam-carriages, and the manner in which the machinery adapted itself to the irregularities of the road, were triumphs of engineering."

The failure of many of the early steam road locomotives was due to the want of proper materials, caused in most cases by the penury of the promoters. The design was often faulty, and the workmanship was invariably bad. The combination of coach and engine in one machine increased the difficulties, and another cause of failure was high-speed running on the worst possible roads. These carriage-builders injured their own cause by a foolish attempt to compete with railways, whereas such carriages can only act as feeders to the railways. In addition to these difficulties, prejudiced people did their utmost to place every conceivable obstruction in the way. Gurney's carriage was seized by an infuriated mob during one of the tests. "The steam-carriages of the early days," says one writer, "were hooted and hissed at by road authorities, coach-drivers, publicans, and the multifarious men w
delighted in horses, which perhaps was not to be wond
seeing that the interests of these men were at stake."

However, the road locomotives of to-day will h
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road locomotive and its train, and indeed for all kinds of vehicular traffic. The foundation of the road is made in the usual manner, the surface consisting of a layer of granite, or other road material thoroughly embedded in sand. A road-roller is used, and it should be heavy enough to squeeze the metal into its bed. The stones settle down with their sharp angles interlocking and their flat surfaces uppermost, for the road is made *for* the traffic and not *by* it. "The stones, instead of being left loosely upon the surface to encounter the grinding lateral pressure of the wheels, are forced by direct vertical pressure into the bed prepared for them, along with a binding material that fills up the interstices and—affording support for the stones—keeps them in position with one surface only exposed to the abrading action of the wheels. The whole coating is consolidated, and there remains a surface hard and smooth." Such a road will reduce the wear and tear of road locomotives to a minimum. But road engines are doing well in some foreign countries where the roads are anything but good. In France some road locomotives are successfully employed, and they have to traverse roads which, even when level, are full of great holes, and where open drains run across them without any covering. In many countries a macadam road is out of the question, but in the meantime we may state from experience that any road that is suitably made and maintained for ordinary vehicular traffic will do equally well for the use of the high-speed locomotive and its train. The latter, being spring-mounted and provided with broad wheels, will do little or no damage to any well-made road.

Mr. Fisher, in America, and Mr. Ricket, in England, turned their attention to this subject, and both these engineers proposed to separate the engine from the coach. The latter sent out several locomotives and coaches for passenger service in Spain, where the engines would draw a load of four tons, at 10 to 15 miles an hour. They were simple in construction, without any cog gearing, made almost entirely of wrought iron and steel.

Twenty-five years ago there was quite a rage for quick-speed road locomotives. A special type of engine introduced by Mr. Thompson was made by several of the leading firms in England, and sent to all quarters of the globe. This type was furnished with a separate tender behind for carrying the feed-water, wood, fuel, etc. Whatever success was achieved by these road steamers was due mainly to the india-rubber tires, for it is impossible to ignore these: they act as an excellent spring, and are placed where the spring should be situated,—that is, at the point nearest to the road, thus saving the engine from a great amount of wear and tear and rough usage; they are perfectly noiseless; owing to their flexibility, they always possess a regular amount of surface of adhesion; the injury to the road may be said to be *nil*, for there never has been any complaint on account of damage done by them; and they enable a road locomotive to travel over the highway at a sensible speed.

The Thompson quick-speed road steamer is not yet an obsolete type, for one firm alone has built about sixty of these engines, and many of them are still doing good service, and where high speeds are allowed they will run eight to twelve miles an hour easily. In some districts where a number of these engines are used it is said that at first the horses were frightened, but they soon became accustomed to them, and would pass them without difficulty when the locomotives were traveling at comparatively high speeds. Another of Thompson's road steamers has attached a coach intended for passenger service. Engines of this type are now occasionally built, and possess many advantages, but the great cost of the india-rubber tires militated against their extended use.

Another English firm has recently made a goodly number of quick-speed road engines, several of which are running passenger trains in India, drawing an omnibus weighing two to three tons, at eight to twelve miles an hour. The engines are mounted upon wheels fitted with steel spring spokes. Three engines of this type, built for the *Fourgon poste* service in the south of France, are running regularly between Lyons and Grenoble, which are about seventy miles apart. This service consists of the collection and delivery of parcels and light merchandise, in districts remote from railways, or indifferently served by them. In France the prejudices of the authorities against steam on the common roads has been overcome, and several of the well-known Serpollet steam carriages are in ordinary use in the streets of Paris and other cities. The speed is restricted to ten miles an hour, and the experience is that horses are not frightened.

After reviewing the progress that has thus far been made in quick-speed road locomotion, we may consider the type of engine best adapted for the purpose. It will be impossible here to enter into minute details, but our remarks are the result of many years of actual experience with various forms of road locomotives. The ordinary traction engine of English make is successfully used for heavy haulage purposes, and these engines with rigid wheels will run five or six miles an hour on level roads if allowed to do so. It should therefore be a comparatively simple matter to modify the details so as to enable them to run seven to eleven miles an hour. The standard type of traction engine is the survival of the fittest. We have seen some wondrous engines in the past, but *the best remains*, and it is the one that may safely be adapted for this purpose.

The engine and passenger omnibus are mounted on elastic wheels. The boiler decided upon is of the well-tried locomotive multitubular type. The engine parts are bolted on the top in the usual fashion. The sides of the fire-box shell are carried up, into which the bearings of the shafts are secured. Two speeds are provided for in this instance, the proportions of the gearing being modified for giving an accelerated traveling speed on the road. Our calculations are based upon a ratio of 5 to 1 for the fast speed,—that is, for quick traveling the engine crank-shaft would make five revolutions to one of the main axle; for the low speed the gearing ratio would be 8 to 1. As a general rule the quick speed would be used, the slow gear being intended for cases of emergency, such as mounting inclines, traversing bad roads, or passing through crowded thoroughfares. These proportions of spur gearing would cause the engine to run eleven miles an hour when driven by the quick train of wheels, and seven miles an hour when slow-gearing was in operation. The driving wheels are taken as being 6 feet 4 inches diameter, and the engine must make 250 revolutions per minute to obtain the above results. In order to suppress all noise caused by the gearing, the teeth of the wheels should be carefully pitched and trimmed, and the pitch of the teeth must not be too coarse. Pitch chains are less noisy than spur-gearing, and, when properly carried out, they form an excellent driving medium. Driving chains are now used on hundreds of traction engines in England. But cast-steel spur wheels are more reliable, and the noise must be prevented by carefully-formed cogs, and all the moving parts should be well cased in to further reduce the noise.

The weight of the engine must be cut down to the utmost limit compatible with the requisite strength of parts, and tractive force required to haul a load of coal of ten tons. This question of weight is an important one, because so many bridges outside of England are incapable of bearing heavy weights. We see no difficulty in making an engine with a single cylinder 8 inches in diameter, having a stroke of 12 inches, working at 140 pounds pressure, that would easily give off the required power, the engine's total weight, fully equipped, to be about seven tons.

Some of our readers may ask why we specify a single-cylinder engine now that the compound system is coming into favor? We recommend the simple engine because it is handier, lighter, less costly, and has fewer wearing parts. The compound system does secure a small saving in fuel, and it is less noisy than the single-cylinder engine, but experience shows that the economy of the compound type when compared with the simple engine, both working at 140 pounds boiler pressure, is less than some makers specify. Moreover, the simple engine possesses advantages that the compound engine cannot claim, rendering the former engine more suitable for unskilled drivers, and colonial work generally. Ample tank capacity would be provided, so that the engine could travel long distances without stopping to take in water. Coke might be mixed with the coal so as to reduce smoke, and the noise from the exhaust nozzle could be suppressed. Quick running is out of the question unless the engine is mounted on springs. Although many spring-wheels have been introduced lately, few have survived. None of the wheels with elastic spokes answer as well as the india-rubber tires. A good form of spring-wheel has been used on some steam coaches, "consisting of an iron boss and about one-quarter of the quantity of india-rubber put round the boss of the same thickness as in the Thompson type. Impinging upon the india-rubber were blocks of wood endways of the grain held between two steel-plates in which they could work in radial slots, and those blocks rested upon the road, affording the same flat surface that the Thompson tire did, and giving considerable tractive power." Many other details of these quick-speed locomotives might be referred to, but space is wanting here. Careful drivers can do much to render the machinery inoffensive to horses, and as these engines become more numerous the horses must be trained to meet them without fear. Indeed, we believe that the horses would soon be reconciled, if the drivers and *riders* of these animals did not *shy* at road locomotives.

MECHANICAL AIDS TO BUILDING.

*By George Hill, **M. Am. Soc. M. E.***

THE treatment of this subject requires that we bear in mind that, broadly speaking, every step is included from the time when we take the raw material from mother earth until, having passed over long distances, through multitudinous processes, and many hands, the finished products of many an industry are laid down at the site as the raw material from which the future building is to be made. We might then, look on our subject with so broad a view as to see it in its entirety, and attempt so to treat it. But if we should, we would have an interminable series of papers, impossible of satisfactory treatment by one mind, no matter how great its experience or how broad its knowledge.

This being the case, we shall confine our consideration at present to those mechanical operations which take place on or about the site, illustrating present practice. If our first thought were to to be followed, we would also establish a comparison of the methods of to-day with those of a generation back, but a little study would show that the advance has been but little and that we are only now beginning to realize what might be done.

The first step in the journey is the preparation of the site for the future building, and this is proceeded with variously, according to the conditions involved. It may be that the site is a mass of rock rearing its head above the street, to be subdued only with steam and dynamite. We would then start a rock-drill of one of the well-known types [Figure 1] usually driven by steam furnished from either a locomotive boiler [Figure 5] or an upright boiler [Figure 6], where the boiler is shown in conjunction with hoisting apparatus, or [Figure 11] in connection with a pump, or one of the electric drills, [Figures 2 and 3] driven by current from the street. It is quite probable that in order to get the boiler to the site the team dragging it would have to wallow through the mire of an un-paved street; but that is one of the beauties of our civilization. It is also more than probable that the shell of the boiler would be left entirely uncovered, radiating from each square foot of surface then heat-units at the rate of 400 per hour, under ordinary conditions, which means 6 pounds of coal for the average boiler when the temperature difference is 200° F.

To farther carry out the same idea, the piping to the rock-drills is usually of bare wrought-iron, and at least a portion of it is conveyed through flexible hose, none of which is protected. This is well shown in Figure 4, where the bare steam-pipes can be distinctly seen. The blasting, although not done with that degree of art

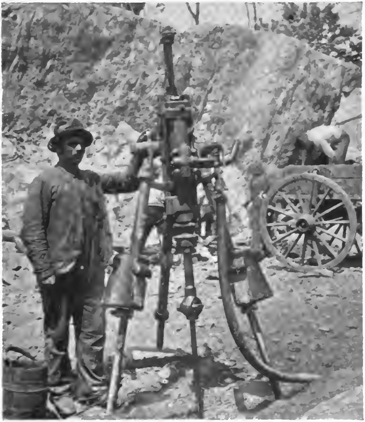

FIG. 1—STEAM ROCK-DRILL.

employed in the large quarries, still requires very considerable skill on the part of the foreman to prevent flying rocks from injuring adjoining buildings, and to avoid shaking them injuriously, but generally the results are satisfactory.

If, instead of having rock to deal with, the site should be near the old shore of the river or lake, as is the case in some part of almost every large city in the world, with silt, clay, sand, and gravel mixed together, or if the site is alluvial and the characteristics of the soil unknown, test-bearings become necessary, and we require mechanical assistance in making them.

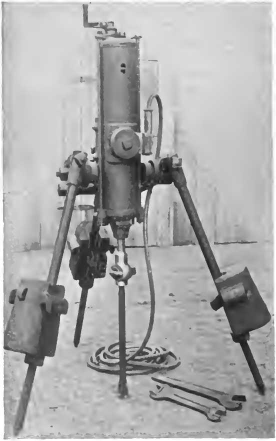

FIG. 2—RECIPROCATING ROCK-DRILL.
[As durable as a steam-drill; requires a special generator for the electric current.]

If the soil is compact and of very considerable depth, an exaggeration of the primitive auger is often used, and occasionally used successfully for depths of about twenty-five feet. The auger is turned down by hand and then withdrawn with a sample of the soil fast in it; or a pipe may be driven down and the soil removed from it with an auger, or a

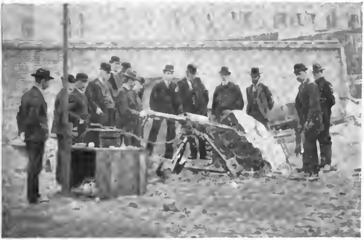

FIG. 3 · ROTARY ROCK-DRILL.

[Handled with the same ease as a steam-drill. Can be used with any continuous current generator.]

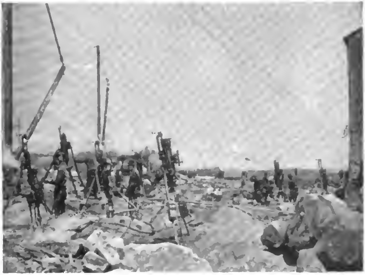

FIG. 4—STEAM-DRILLS AT WORK.

[Boom derricks to the left for removing rock.]

sand pump, which is simply a short length of pipe with a clock valve at the bottom, the cutting of the pipe as it is forced down affording the samples; or it may be found desirable to sink a considerable number of holes round the site, or to go to a considerable depth. In this latter case a machine like that shown in Figure 7, which is the one used by Professor Charles B. Brush, may be employed. This machine is similar to a pile-driver, the pipe being driven down by the use of a light ram. As it goes down water is pumped through an interior tube, shown beside the barrel and connected with the pump by means of a flexible hose. The water flows up in the annular space between the two tubes, carrying in suspension such of the material passed through as would otherwise fill the pipe; samples are recovered from the water by settling. The purpose of the tests being to determine the safe load that can be placed on the soil, it is necessary that the engineer who expresses the judgment should be familiar with the method employed to obtain the samples so as to correctly interpret them.

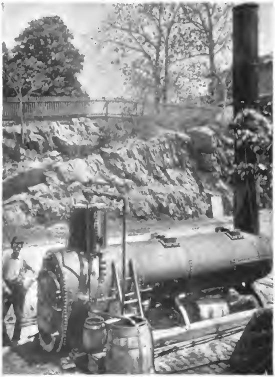

FIG. 5—SEMI-PORTABLE LOCOMOTIVE BOILER.

It occasionally happens that the building is to be erected along what was formerly a river front, or where the ground has been filled in to level an inequality. This requires that the bearing value of the soil be determined in a different way, and the only satisfactory method is by driving test piles. For this purpose a pile driving machine [Figure 25] is used, and the behavior of the pile under the hammer observed by an expert; the amount of penetration under each blow, the weight of the ram and the height of the fall, the size and material of the pile, all are necessary elements. Instead of the machine shown in Figure 25, which is the old style, one of the newer kinds shown in Figure 8 might be used, in which a greater weight is made effective.

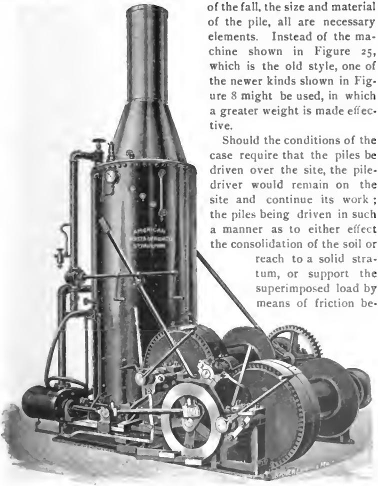

FIG. 6—UPRIGHT BOILER.

[With cast-iron base, double cylinders, double hoisting drums, and two winch-heads.]

Should the conditions of the case require that the piles be driven over the site, the pile-driver would remain on the site and continue its work; the piles being driven in such a manner as to either effect the consolidation of the soil or reach to a solid stratum, or support the superimposed load by means of friction between the mud and the skin of the pile. In any case the fact must be borne in mind by engineers that the proportion between dead load and live load in the case of a building is altogether different from that in the case of railway bridges and the like, and that a pile

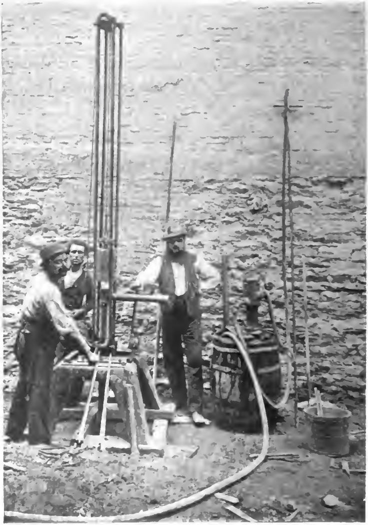

FIG. 7—BRUSH'S SOIL-TESTING APPARATUS.

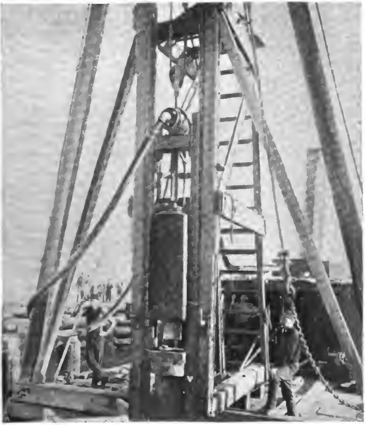

FIG. 8—STEAM HAMMER.

[The operating piston is inside the weight. The steam hose passes in front of man to left. Valve is in the sphere between the ways.]

would often fail under the prolonged application of a load very much less than it would safely withstand for a few moments. For this reason the formula usually adopted for the safe load of the piles cannot be used without modification. This being the case, the objection of some engineers to having the fall fastened to the hammer permanently, on the score of friction losses, is rather hypercritical. Were the amount of excavation large we might use one of those forms of excavators of which a type is shown in Figure 9.

If the soil is sandy or soft, sheet piles will be necessary to keep it from caving in, and that, by an application of the steam rock-drill [Figure 10], can be most easily done ; oftentimes a large wood mallet is used instead. Should it be necessary to keep the excavation free of water, we can use one of the Worthington pumping outfits [Figure 11] or one of the Pulsometer outfits [Figure 12], each having a use to which it is best adapted.

We may now consider that the site is ready for the building, and proceed to put in the foundations. Where these are of large stones, they may be handled either by means of moderate sized erecting derricks, the stones being dropped on to the ground, and then carried by means of rollers running on planks to a position under the derricks, the derrick lifting them up while a bed of mortar is being prepared for them and then lowering them into it, or else one or more boom-derricks may be used, which take the stones from the vehicle and deposit them either under the erecting derricks or in their proper place in the work. Some of these are shown in Figure 4 ; a very good type is also shown in Figure 13.

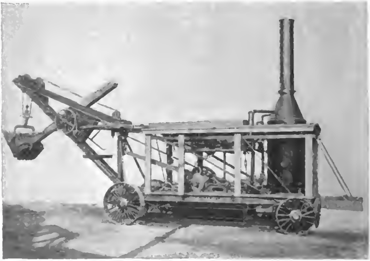

FIG. 9—PORTABLE EXCAVATOR.
[Self-propelling type, with ¾ yard dipper.]

These derricks are used throughout the balance of the construction and put in place the iron, steel, stone, or timber that may be needed. Where the work is of considerable size, skeleton derricks of the Norcross type [Figure 14] are used; these are so arranged that the swing of the boom includes every portion of the site, and material may be passed by them entirely around the building. They are also arranged as crane derricks, as shown in Figure 15. If in addition to considerable area the building is of great

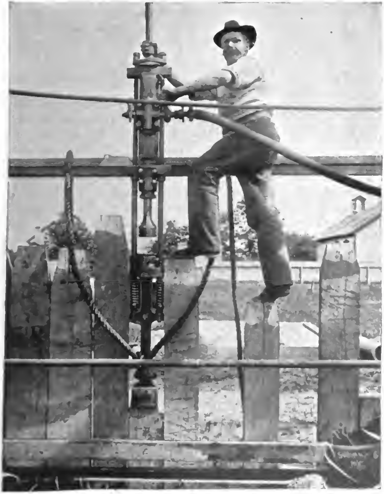

FIG. 10—STEAM SHEET PILE-DRIVER.

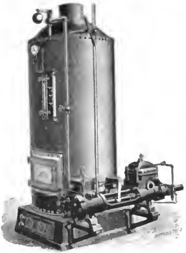

FIG. 11—PUMPING OUTFIT.

height, the plan adopted in the erection of one of the Chicago buildings may be very successful. In this the hoisting-engine, which was really a traveling crane, traveled on a track laid just within the exterior walls of the building, and as soon as the story above was erected, pulled itself up an inclined plane to tracks laid on that story and proceeded with the erection.

A similar arrangement has been used with small boom-derricks in the erection of many of the Massachusetts mills. The mast of the derrick in this case is lifted vertically by means of the fall from floor to floor as the work progresses. Where large derricks are employed it has been found to be particularly advantageous to have the bricks used in the erection of the building packed in boxes of a special size, usually arranged to

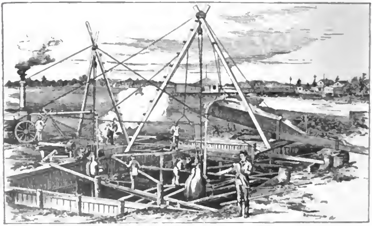

FIG. 12—SEMI-PORTABLE PUMPING OUTFIT.

[Pumps are lowered as the pit deepens.]

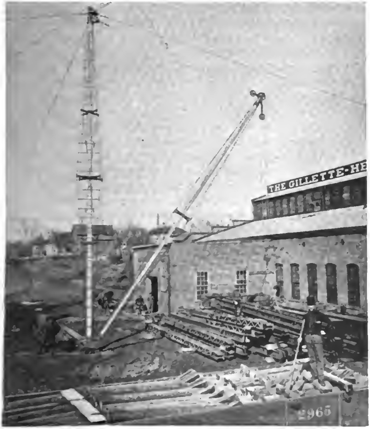

FIG. 13.—BOOM DERRICK.

[Steam power, braced tubular mast and boom. Capacity five tons.]

contain 2800, which fit comfortably in the wagon-body and have means provided whereby the derrick can lift them out at once into the work. A particularly good example of this and of the skeleton derricks may be illustrated by the erection of the Equitable building in Denver. [Figure 15.]

For the handling of the mortar, the usual method is to mix it by hand in boxes somewhere around the site, hoisting the hods filled with it up to the working floor ; and this is done either in an elevator of the usual form or in a hod-hoisting machine consisting of an endless chain rotated over sprocket wheels and carrying the hods in claws fastened to the chain. The usual form has the lift operated by means of an engine lift, shown in Figure 6. If, however, the contractor is very much up to date, and is using a mortar-mixer for the cement mortar and for the lime mortar, he may send it in boxes of the proper size to the building and deliver it to the working floor without breaking bulk, or the ingredients may be delivered and the mixing done on the floor where the work is being prosecuted. The advantage of so doing depends on the perfection of the organization of the force and is at times a minus quantity.

From recent experience in Chicago in the erection of the World's Fair buildings, it is probable that in the large cities a change will soon be introduced in the motive power of these various machines, and the illustrations heretofore given will have more of an historical than a practical interest, in their details.

In Chicago, in the erection of the buildings for the World's Fair, electricity played a prominent part, and some of the uses to which it was put are illustrated in Figures 16 to 23, where it is

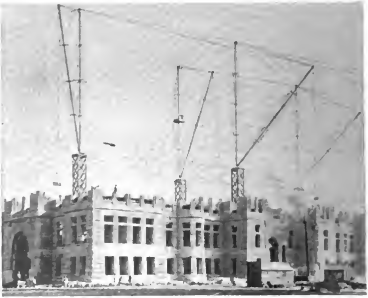

FIG. 14—SKELETON BOOM DERRICK.

[Braced tubular mast and booms, steam power. Used in erecting the City Hall and Court House, Salt Lake City, Utah Masts 80 feet, boom 75 feet, capacity five tons.]

shown sawing and planing wood, painting, erecting materials, etc., and in all of the operations we have been describing, it could be used in lieu of steam except, perhaps, only in the case of the pile driving machine, where it is probable that, owing to the peculiar conditions of the service, either an excessively large machine would have to be used, or one of a different type devised with a means of storing up energy. It is to be noted however that this has been very successfully done in France, although the details have not been published.

To effect a comparison consider the two cases in contrast. In the one case triple expansion condensing-engines of considerable power working under a uniform load, tended by competent assistants and generating a current which is sent over a few miles of line and is ready at all times for immediate use. This should mean an expenditure not to exceed two pounds of coal per actual horse-power hour. If we allow for an equal amount lost in transmission, and to cover cost of plant, etc.,—and this should be extremely liberal,—we should have an expenditure of four pounds of coal per horse-power

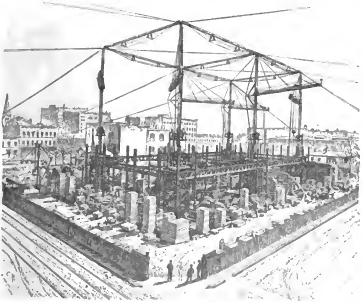

FIG. 15—SKELETON CRANE DERRICKS.

[Hand power, masts braced; used in the erection of the Equitable Building, Denver, Colorado.]

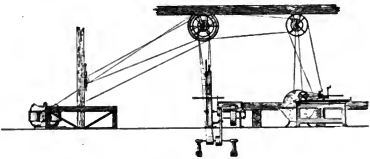

FIG. 16—SAW-MILL IN AGRICULTURAL BUILDING.

[Twenty horse-power motor driving boring machine, band-saw, rip-saw, cut-off saw, and grindstone.]

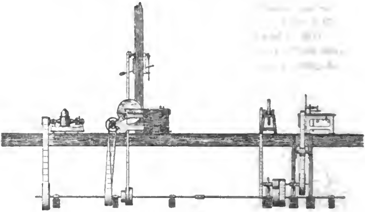

FIG. 17—SAW-MILL IN MACHINERY HALL.

[Twenty-five horse-power motor running same tools as in Fig. 16.]

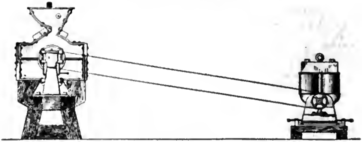

FIG. 18—AUTOMATIC PULVERIZER AND MOTOR.

[Pulverizing clay for modelling.]

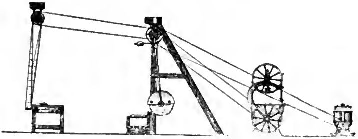

FIG. 19—SAW-MILL IN ELECTRICITY BUILDING.

[12 kilowatts motor running band-, rip-, and cut-off saws]

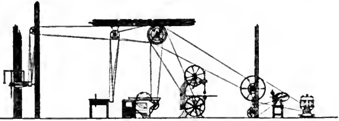

FIG. 20—SAW-MILL IN MANUFACTURE BUILDING.

[12 kilowatts motor operating saw-sharpener, band-, rip-, and cut-off saws, and boring-machine.]

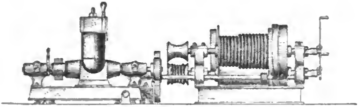

FIG. 21—ELECTRIC HOIST.

[Double-friction drums, double winch-heads, independent bases—practically a detail of Fig. 23. Rawhide pinions used.]

per hour, consumed while work was actually being done, using coal of the cheapest grade under boilers of the most economical type, and most carefully guarded against loss.

On the other hand, the type of boiler most freely used in building operations is the vertical tubular with short tubes, unjacketed shell, and more or less out of order, and such as to require the consumption of at least six pounds of coal per horse power per hour, the coal being of double the cost.

The engines which transform the energy of the steam into useful work are usually of the most ordinary kind, with steam follow-

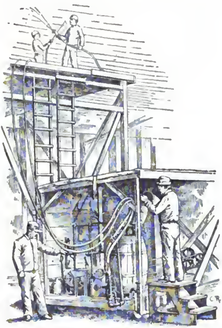

FIG. 22—PAINTING MACHINE.
[Used at the World's Fair. Motor drives small air-compressor. Paint applied on the same principle as the air-brush.]

ing practically full stroke, controlled by means of a manually operated throttle valve and generally left to care for themselves. So far as the writer can learn, the consumption of coal is in the neighborhood of twenty pounds of coal per horse-power per hour. Add to this that the engines are working but a short portion of the time while steam is kept up ready for any call upon it, usually blowing off at the safety-valves, and the enormous consumption of coal is easily accounted for.

Enough has been indicated to show that such wasteful methods cannot be continued and the assertion made in the early part of this article justified. As a further illustration

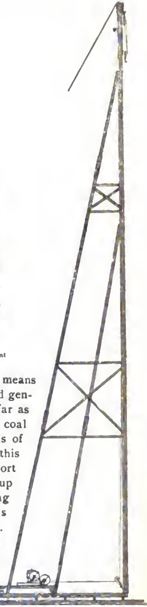

FIG. 23—ELECTRIC HOIST.
[20 kilowatts shunt-wound motor.]

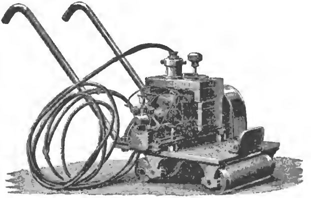

FIG. 24—DECK-PLANER.

[Could be used for planing floors if slightly modified.]

of the same fact, witness the uses made of electricity at Schenectady, N. Y., where the Edison Company have a motor in a house on a crane like that in Figure 13. The painting machinery at Chicago [Figure 22], the deck-planer, equally applicable to floors [Figure 24], the very satisfactory operation of rock drills, one of

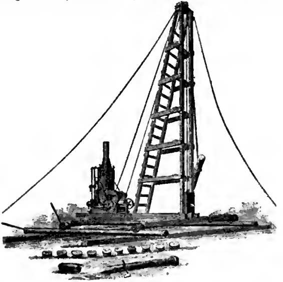

FIG. 25—PILE-DRIVER.

[Single cylinder with two winch-heads; single hoisting drum and improved rolling gear.]

rotary type being shown in Figure 3 and of reciprocating type in Figure 2, and the fact that one of the regular manufacturers of hoisting machinery is now making electric hoists, would make it truly seem as though electricity were the coming power.

That this is so will probably be admitted. Where there is ample opportunity for procuring power at a moderate rate, it is probable that its convenience will lead to its universal use.

There is, however, in a gas-producer and gas-engine and in a natural-gas country the probability of a still more economical prime mover. In this case the use of the double cylinder so common in the hoisting rigs would be kept up. The engine would be constantly in motion, and the probable result would be an economy in fuel approximating two pounds of coal per horse-power per hour of actual work performed, and this coal the common pea coal.

It would be but a simple matter to carry the gas made either in one of the usual forms of portable producers or taken from the pipes in the street, through pipes in the building up to the place where it was needed ; the method of distribution being such as to make it readily applied in pipes of moderate size. So far as the writer knows, no attempt to demonstrate economy in this line has as yet been made, and therefore no data can be given ; but it seems as though it would be worthy of investigation.

THE SAFETY CAR-COUPLER PROBLEM.

By W. M. Mitchell,

Kansas Board of Railroad Commissioners.

IT seems hardly possible for one to say anything on the question of safety car-couplers that has not already been said ; yet the passage by the United States Congress of a law bearing directly on the subject has created a new public interest and must of necessity awaken further discussion. Heretofore discussions in this field have been principally prospective, but now the subject has assumed definite form. In times past the various advocates of safety appliances have made vigorous use of the fact that a large number of our citizens are annually either killed or injured (as chronicled in the newspapers, showing a frightful mortality from this source), for the purpose of inciting a public clamor for legislation on the subject. Such efforts were attended with varying results until recent political disturbances indicated to the alert and wily politician, who is ever ready to grasp that which bids fair to yield the greatest returns in the way of ballots at future elections, that the time had arrived when the long-promised action on the question of safety appliances must take definite form, in order to secure in the future, as in the past, the class of votes affected by such legislation. The result was that on March 2, 1893, a bill providing for automatic couplers and power-brakes passed both branches of Congress, was laid before the president, received his signature, and became a law.

The bill, in brief, provides that on or before the first day of January, 1898, it shall be unlawful for any railway company doing an interstate business to employ in such traffic any car or cars equipped with automatic couplers that will not couple by impact, and that they must not run any train in such business that has not a sufficient number of cars equipped with power-brakes to control the speed of the train, without compelling the brakeman to use the hand-brakes for that purpose. It would seem that a measure providing for uniformity of automatic couplers, coupling by impact, that can be uncoupled without forcing the employé to go between the ends of the cars to perform that duty, and obviating the necessity of going on top of a moving train to regulate its speed, would forever avert a source of death and injury which has been fruitful in the extreme.

A few statistics at this point, by way of illustration, may not be uninteresting, and will demonstrate that there was a necessity for legislative action. The Interstate Commerce Commission has given careful and painstaking attention to this question, and its conclusions are as trustworthy as any that can be obtained. I quote from their report for 1890:

> The most common accidents to which railway employés are liable result from the coupling and uncoupling of cars. The casualties that can be traced to this source alone are 8212, of which 369 were fatal; of this number, trainmen sustained 5338 accidents, 265 of which were fatal.

In other words, one-third of the accidents upon railroads can be traced to coupling and uncoupling cars. The adoption of these safety appliances will not only materially reduce the accidents to employés in coupling and uncoupling cars, but also eliminate the item of "falling from trains and engines" and "overhead obstructions." Using the figures found in the same report, we find that 42 per cent. of the number of employés killed and 47 per cent. of the killed and injured are traceable to the three above-mentioned causes.

There were in use on the railways reporting to the Commission forty-five different automatic couplers. In 1889 there were 80,510 cars equipped with various kinds of automatic couplers, and in 1890, 115,319,—an increase in a single year of 35,809 cars. This should have reduced the number of casualties, and would have done so in my opinion, if the couplers had been of uniform type, but as a matter of statistical record there is no decrease in the number of casualties from the preceding year.

It has been claimed by many that the general trend of railway practice was toward the adoption of automatic couplers, yet it cannot be denied that it required some such act as the one mentioned to secure complete uniformity, and render to the employé as nearly absolute protection from accident as it is possible to attain under the present mode of operation of our railways, which is hazardous at best. It has been remarked that there are certain inherent difficulties attending the coupling and uncoupling of cars under the best conditions that render the service dangerous in any event, and that this fact is to a degree responsible for the large number of automatic couplers that have been invented, which is no doubt true to some extent. Yet it is hardly possible that the inventors in all instances have been moved alone by philanthropic motives in their work. The difficulties referred to are numerous, and to the experienced railroad man are as familiar as the cars themselves,—for instance, the coupling and uncoupling of cars standing on a curve, or those of uneven height, or cars loaded in such a manner that their burden projects beyond the ends, and which, when placed in position to be coupled, come in collision with each other. This latter difficulty is met more frequently in the construction of railways when the cars handled are loaded with bridge timbers, rails, piling lumber, etc.

The dangers above enumerated are largely increased by the unevenness of the roadbed and the neglect of surfacing to a level with the tops of the cross-ties. This needed work seldom reaches to the outside of the rails except in the large yards at terminal stations, and, when the train-men are forced to couple or uncouple a moving car, they must either get clear inside the rails and take the chances of stumbling over some unseen object, which means almost certain disaster, or run along on the outside of the rails over the exposed ends of the cross-ties, an extremely hazardous undertaking, especially when the rails are covered with ice or snow. Last, but not least, come the lurking dangers of the unprotected switch-frog and guard-rail, which have been one of the most prolific sources of accidents in the railway service. The unwary employé in the hurry of making up a train, who was obliged to step between the moving cars to make a coupling or pull a pin, and unwittingly forced his foot into a switch-frog or between the guard- and main-rails in such a manner that it would be held as if in a vice, was in danger of being crushed before the foot could be extricated.

These reasons, as stated, are largely the cause of bringing into this field the genius of the inventor, who sees the necessity for some immediate protection from accident to the thousands of our citizens who are engaged in this hazardous and necessary employment, the result being a great number of inventions in the direction of safety.

It will now be seen that where there has been no concert of action in selecting the most practical coupler to put in use, and where each individual railway official has been left to his own choice in the premises, a large variety rather than a uniformity of couplers must of necessity have been the inevitable result. It could be no more expected that the same type of coupler would be selected by all the railways than that all men would crave the same food or enjoy reading the same book, or that in the selection of a profession all men would elect to become lawyers, or doctors, or ministers. It is human nature for men to differ in business methods as well as tastes; hence the reason for a disparity in safety-couplers and the necessity for legislative action along the line set forth in the bill of March 2.

It cannot be gainsaid that the railways under past circumstances have been as progressive as could have been expected, yet, under the conditions attending the early days of railway building and operation, there was a wide disparity of gage, which was intensified when applied to the rolling-stock. There were not in those days, as at the present, independent shops for the manufacture of cars. Each road had a shop of its own, with a master car-builder at its head, whose peculiar ideas regarding the architecture of the cars to be built under his supervision resulted in each road placing cars upon its tracks which, when interchanged with other roads,—when the gage would permit,—were as easily distinguished by their general outlines as by the inscription on their exterior, and this peculiarity of shape was no more prominent than that of its coupling-device, whose size, shape, and height, from the top of the rail to the center of the drawbar, lent its influence to increase the dangers of coupling and uncoupling cars.

The first noticeable step in the line of progress towards uniformity was the change of gage, a step forced by the demands of commerce, but of course not affecting the construction of cars. There was no marked improvement in this direction until the business of the railway companies increased to such an extent that they were unable to construct their cars as rapidly as their business demanded, and they were forced to purchase them from the companies that had in the meantime been organized for the exclusive purpose of constructing rolling-stock. Thus the step toward the era of uniformity in height and shape of cars was entered upon.

Barring the existence of many thousands of cars already constructed, in such good condition that the companies could hardly be expected to discard them for the sake of uniformity in their rolling-stock,—which is a very plausible argument that can be used against the taking effect of the act until the old cars shall in the course of events have outlived their time of usefulness,—there is but little room for argument why the act should not become effective. Yet this reason cannot be given for not complying with the requirements of the law in the construction of new cars, or of old ones sent to the shops for repairs, by placing upon them some type of coupler that will successfully intermingle with those of other roads and that can be coupled and uncoupled without the necessity of the employé entering between the ends of the cars to perform that duty, as required in the above act.

It was urged by many who opposed the passage of the act that, if its provisions were enforced, the railway companies of the United States would incur an expense of at least $75,000,000. Perhaps that amount would cover the expense, but would not the expenditure of $75,000,000 be a good investment if it insured the protection from injury of 22,396 persons and saved the lives of 2451 more every year, to say nothing of the wrecks, with their attendant loss of property, delayed trains, damage suits, etc.?

This law strikes a direct blow at the root of the evil of non-uniformity of couplers, in providing that they must be susceptible of intermingling, coupling by impact, etc., and it would have been difficult for Congress to have done more and protect the rights of all,—the inventor, the employé, and the railway companies. The act as it stands leaves open to the inventor the field of competition. It does not bind the railway companies to the adoption of any certain coupler, and thereby subject them to the possible unreasonable exactions of the fortunate inventor whose production might have been selected. At the same time it insures to the public and employés the protection so long sought, by providing that the coupler adopted must contain certain elements of safety; hence it would be difficult indeed to suggest an improvement to so wise and far-reaching a measure.

The fact that this act of Congress has been signed by the president and has become a law raises the question as to type of coupler best calculated to meet the requirements. In this discussion we should not lose sight of the diverse interests that must enter into the determination of so momentous a question. The rights of the inventor whose production is possessed of more or less merit, those of the railway companies with their numerous varieties of couplers already placed in use, and the elements of safety that must be considered as the rights of the public and the employés, must all be kept in mind.

ELECTRICITY.

Conducted by. Franklin L. Pope.

PROFESSOR MOSES GERRISH FARMER, of Eliot, Me., who died in Chicago on May 25, although but little known to the present generation of electrical workers, was one of the most accomplished electricians, as well as one of the most remarkable men of his time. Born in Boscawen, N. H., in 1820, he manifested in early life great ability as a mathematician and a strong predilection for scientific pursuits. Illness and lack of means constrained him to relinquish his studies while yet in the midst of his college course, and to seek employment as a teacher. In 1845 his attention became directed to the study of electromagnetic phenomena, and from that day to the end of his life he devoted himself with unbounded enthusiasm and unceasing diligence to the study of electrical science with reference to its industrial applications. It is not too much to say that almost the whole art of electrical engineering in the United States has been built upon the foundations which he laid. He entered the telegraphic service in the capacity of operator and inspector in 1847, having previously invented and built an electric locomotive, and acquired some local fame as an experimental lecturer on electricity and magnetism. His first notable achievement was the construction of the municipal electric fire-alarm of Boston, which he completed in 1851, a work which properly takes rank as the beginning of the art of scientific electrical engineering, not only in the United States, but in the world. The differentiated automatic signalizing apparatus; the control of powerful mechanical forces at a distance by a feeble electric current; the constantly closed circuit in which signals are given by interruptions; the application to such circuits of the sustaining battery; the application of the magneto-electric current machine for the production of currents of great dynamic power, and of water-power for driving the magneto-machines: the protection of conductors by placing them, insulated, in wrought-iron pipes; the protection of the signal stations from the destructive effects of lightning by the "plate-arrester,"—all these and innumerable minor devices essential to the efficiency and trustworthiness of the system had to be originated by him, for there existed at that early day no precedents by which he could have been guided. The success of the electric automatic fire-alarm for the first time demonstrated that electricity, when intelligently handled, was an agency which might be depended upon, as implicitly as heat or gravitation, to do its appointed work. A mere catalogue of Farmer's inventions aud investigations for the next twenty years would fill pages; some of the most important of the former are the automatic repeater and the double-current system of duplex transmission, each of which now forms an indispensable part of the equipment of all the principal telegraphic systems of the world; the automatic printing telegraph, which modern Wall Street knows and reverences as the "ticker"; the automatic regulator for incandescent lighting systems; and, most important of all, the auto-exciting dynamo-electric machine. In this last, Siemens, Wheatstone, and Varley were independent and nearly contemporaneous inventors, but it is certain that the earliest written description of such an apparatus was contained in a letter written by Farmer to a distinguished English electrician. Notwithstanding the benefits which his inventions and discoveries conferred upon the world, the story of the first fifty years of Farmer's life is one of almost incessant struggle against poverty, sickness, and discouragement. He was literally one of those men who have no time to stop to make money. In 1872 he was made proessor of electrical science in the United tates Naval Torpedo Station at Newport, position most congenial to his tastes, nd one in which he rendered the government most valuable service, until his inreasing infirmities compelled his resignaion in 1881. Since that time he has lived n comparative retirement, having been onfined to his chair by a paralytic affection. To Professor Farmer, perhaps more than to any other man, may be traced the origin of the influences which have placed the United States at the head of the nations of the world in the originality, the diversity, and the extent of its industrial applications of electricity.

IF the true history of the art of illumination by electricity is ever written, the extent and value of the pioneer work of Professor Farmer in that field should receive the recognition to which it is justly entitled. He foresaw as early as 1858 that electricity was certain to become the illuminant of the future. and that for subdivision and domestic lighting incandescence was the only promising method. In that year he experimented with platinum and iridium burners, and ascertained the law governing the relation between heat, light, and current, which showed him that the efficiency of the lamp increased in an enormous ratio as it approached the fusing point. He was taught by this circumstance to make his lamps of equal resistance, to arrange them in multiple arc, and to automatically regulate the current at the common source of supply, and not at each individual lamp. During the month of July, 1859, he illuminated the parlor of his house at Salem, Mass., by lamps of incandescent platinum, to the admiration of all who saw it. Appreciating the fact that the most formidable obstacle to the introduction of electric lighting was the cost of electricity, as then derived from the voltaic battery, he devoted himself assiduously to the perfection of the thermo-battery, in which electricity is derived from the direct combustion of gas or coal, hoping to find in this direction the solution of his problem. In this line of research he met with some measure of success, but he ultimately concluded that a more promising source of cheap and abundant electricity was to be looked for in the magneto-machine. In 1866 his researches in this direction found rich fruitage in the discovery of the principle of the self-exciting dynamo-electric machine, to-day in use throughout the world as almost the sole means of producing electricity for all industrial purposes. He then returned to the problem of electrical distribution, and by 1868 had succeeded in operating 40 incandescent lamps in multiple arc, with absolute automatic regulation at the common source of supply, and in lighting a private residence in Cambridge, Mass., in quite a satisfactory manner. Iridium was found by him to possess the electrical properties necessary for a successful burner, but it was impossible to procure the metal in an available form. If the generating, regulating, and distributing apparatus of Moses G. Farmer and the vacuum carbon lamp of Henry Goebel had chanced to have been brought together, it is quite possible that we might have lighted our houses by incandescent lamps twenty years earlier than we did. All this should not and does not detract from the credit justly due to those to whom we are actually indebted for the electric-lighting system of to-day, but nothing can be more unjust than for us to refuse a generous recognition to the labors of the pioneers, in the absence of which the successes of later years would have been impossible of achievement.

THE curious visitor will find some interesting relics of Professor Farmer's pioneer work in the World's Columbian Exposition; among other things, the armature of his first dynamo-electric generator, constructed in 1866, the only portion of the machine rescued from a disastrous fire which occurred in May, 1868, and the original mantel of his house in Salem, to which were affixed the incandescent lamps of 1859. The lamps themselves have also been reproduced, as accurately as possible, under the personal direction of Professor Farmer, and the whole forms a valuable, though meager, historical exhibit.

THE attempt of parties interested in the promotion of electric traction by storage-batteries, to obtain authority from the Massachusetts legislature to run their cars over a portion of the lines of the West End railway, now operated by the trolley system, has proved unsuccessful. It came out, in the course of a discussion before the committee, that on the Milford and Hopedale line, which has been extensively cited as a successful example of storage battery traction, the figures returned by the railway to the railroad commissioners show that the operating expenses for last year were approximately 37 cents per car-mile, which, from a commercial point of view, cannot be regarded as particularly encouraging.

THE possibilities in the way of the economical distribution of power by electricity, which have been demonstrated by the continued successful operation of a number of large enterprises of the kind, are giving a renewed impetus to the construction of hydraulic works of great magnitude. One of the most interesting of these is the great dam across the Colorado, just above Austin, Texas, the completion of which has recently been celebrated. The dam is of masonry, 1125 feet long, and raises the water sixty feet above its original level. The flow of water is said to be from 200,000 to 250,000 cubic feet per second. It is designed to utilize the power for a pumping station, various factories and mills, together with a system of electrical distribution which will make cheap light and power available anywhere within a radius of several miles.

IN a paper read before the Royal Institution, Dr. John Hopkinson presents some additional figures and facts respecting the operation of the South London Electric railway. He gives the train mileage as 36,000 per month, and the number of passengers as 553,000. In an itemized statement, the cost of operation is divided into two parts, station-working and locomotive-working, both of which include wages and repairs. The former comes out equivalent to 9.18 cents, and the latter 13.80 cents per train mile. The full train load is only 100 passengers, and the average speed between stations is 13.5 miles per hour. From the results above given, Dr. Hopkinson computes that the cost of steam-traction per ton-mile of train is only about one-half that of electric traction, but, as electricity is practically used only for passenger traffic, the proper basis of comparison is the cost per passenger carried one mile, and in such a comparison electricity shows to much more advantage, because the trains can be divided into smaller units and run at more frequent intervals without material increase of expense. The appropriate sphere of electric traction, therefore, in Dr. Hopkinson's opinion, is not for trunk-lines, but for metropolitan and suburban service requiring accommodations at frequent intervals, and for secondary and branch lines where water-power is available.

AN electric street railway is now in successful operation in Bangkok, Siam, the rolling-stock and station machinery of which are entirely of American manufacture.

AN enterprising person in an eastern city, of the shopkeeping persuasion, proclaims that he will pay $10,000 to any person who will discover or invent, patent, and transfer to him, a practical device for propelling bicycles by electricity. He intimates that the storage-battery is probably not the thing. We drop this word of caution to aspiring inventors: When you have invented a successful device of this kind, do not permit yourself to be tempted for one moment by the glittering bagatelle of a ten thousand-dollar prize. Remember that 200,000 bicycles are sold every year However, we think the shopkeeper runs small risk in making the offer, and migh just as well make the amount $100,000 while he is about it.

THE teredo-worm is doing an immense amount of damage of late years to submarine-cable property. Even the heav iron armor heretofore used on shallow water cables has proved to be an insuff nt protection. Within the past two or ee years the worm has made its appear- ce in English waters, and large sections the concrete of the Plymouth break- ter are said to have been completely neycombed by the operations of this baqueous pest. For this reason the new ephone cable just laid between Scot- d and Ireland has been provided with a eathing of brass, which experience has us far shown the teredo does not at- ck.

THE results of a series of elaborate ex- riments made by the well-known elec- ician, Dr. A. E. Kennely, assisted by Dr. rederick Peterson, demonstrate that the man organism is not affected in the ightest degree by the most powerful agnetic field capable of being produced y the resources of modern science, or, in ther words, that magnetism is absolutely appreciable to our senses. But as mag- etism may and does convey dynamic nergy with as much facility as electricity r heat, the paradoxical result follows that t is possible to transmit enough me- hanical energy directly through the sub- tance of a man's brain to operate a air-sized motor, without producing the lightest appreciable effect upon him, ither physical or mental. It has been laimed in times past, however, that there are certain persons who possess a so-called "magnetic sense." It is an interesting question whether or not there is any real foundation for this assumption.

ALTHOUGH the British public were very slow in taking up domestic illumination by electricity, surprising progress has been made since matters fairly got started. It is stated on the authority of Professor Ayrton that by the end of the current year a sum of money equivalent to $25,000,000 will have been expended in providing for the supply of electric current from the public mains in that kingdom exclusive of the cost to the consumers of the interior wiring and fittings. The whole number of incandescent lamps in Great Britain is stated to be equivalent to about 750,000 8 candle-power lamps. The number of lamps on the direct and on the alternating systems respectively are not far from equal; the direct system is, however, ahead at the present time. Storage-batteries have been much used, but it is evident that the present tendency is to discard them, so far as central station work is concerned, and to approximate towards American practice in details of distribution. An aggregate of about 100,000 horse-power of dynamos and motors have been manufactured in Great Britain during three years past.

AN ingenious automatic switch is now applied to the electric lamps in the guests' room in a hotel, whereby the locking of the room-door from the outside (but not from the inside) turns off the lights. Many travelers, it seems, doubtless with the philanthropic idea of helping the business of the local electric-lighting company, are accustomed to leave the lamps burning at full head when they vacate their rooms.

PROBABLY the most extensive electrical outfit in the world, employed solely for mining operations, is that of the Calumet and Hecla Company in the Lake Superior region. The plant has been some two years in course of construction, and comprises nearly every known form of electrical apparatus. There is among other things a complete telephone exchange, connected with which are many miles of telephone and telegraph lines, both above and below ground. Both alternating and direct currents are used for illumination, with voltages ranging from 52 to 1000. Large numbers of pumps, cranes, hoists, etc., are operated with electricity with great facility and economy. The safety and flexibility of electricity seem to render it almost an ideal agency for applying power in the varied and difficult operations connected with the mining industries.

ONE of the most interesting and instructive exhibits at the World's Columbian Exposition is that of machinery and appliances for electric welding. One machine, designed for welding large pipes, requires to operate it an electric current of

80,000 watts, equivalent to more than 100 horse-power. It will almost instantly weld the ends of an iron pipe six inches in diameter. Specimens of railway-track construction are shown in which the chairs are welded directly to the rail, also a three-way crossing in which there are six different welds, none of them less than twelve square inches in cross-section. There is shown a railroad crossing of rolled steel, all welded together so as to form a solid piece. The largest electrieal weld ever made, having a section of forty-eight square inches, also forms part of this remarkable exhibit.

THERE is an Electrical Light Association in Japan, which has issued a volume of its proceedings in the native language. It appears that 20 central stations are now in operation in that country, and the installation of others is rapidly going on. As a precaution against the effects of earthquakes, the machinery is invariably placed entirely upon the ground floor of the stations.

A SMALL incandescent lamp, about the size of a pea, is found extremely useful in the diagnosis of certain diseases. Placed in the cavity of the mouth, it illuminates the face from the interior, and makes it possible to see all the muscles and blood-vessels with the utmost distinctness. By attaching the lamp to a tube it can even be lowered into the stomach, the current turned on, and an examination made from the exterior.

THE Weehawken tunnel of the West Shore railroad (in New Jersey), which is 4200 feet in length, has been fitted with a novel block-signal system, consisting of a line of incandescent electric lamps about 300 feet apart and placed on a level with the eye of the engine-driver. When the lamps are all alight, it is an indication of safety; each train passing through extinguishes the lamps for a distance of 1100 feet in its rear, a result which is automatically effected by an electrically connected track-circuit, whereby the lamps are kept under the continuous control of the train. The operators in the signal-towers at each end of the tunnel can also extinguish the lights in any section of the tunnel if occasion requires. This system appears to embody a number of exceedingly valuable features, and, if successful in practice, cannot but increase the traffic capacity of a long tunnel largely beyond that which is possible by the methods of signalling heretofore in use.

THE International Electrical Congress of the World's Columbian Exposition will be held during the week beginning August 21, 1893. A large number of distinguished foreign electricians have announced their probable attendance. The program has been issued, and the schedule of subjects to be discussed indicates that the work of the Congress is likely to be of great permanent value to the profession. Three popular lectures are announced to be given during the session of the Congress by eminent electrical authorities.

AN immense electrolytic copper refinery has been started at Great Falls, Montana, by a Boston company. It comprises 288 depositing vats capable of containing at one time 1,600,000 pounds of pig copper anodes, and has a capacity of 1,200,000 pounds of pure electrolytic copper per month. The plant is run by water-power, situated at a distance of 2100 feet from the works. The current is supplied by two dynamos, of 165 kilowatts capacity each. The total cost of the plant, exclusive of real-estate, is said to have been over $350,000. The metal refined contains a large percentage of silvėr, all of which will be saved by the electrolytic process.

THE witnesses who have given testimony in the recent investigation respecting the efficiency of the Boston fire-department seem to be unanimous in the opinion that the operations of the firemen at large fires have often been greatly impeded by the lines of overhead electric wires in the streets. The chief of the department observed that the telegraph wires have caused the firemen far more trouble than street-railway wires.

MECHANICS

Conducted by Leicester Allen.

THE steam-fitting work in the power plant of the World's Columbian Exposition probably ranks as the highest manifestation of the art to be found in the world. Not only on account of its unprecedented magnitude, but because of the workmanship, it is in itself a grand exhibit. Besides, it represents all that is best and most modern in the art, which, since the era of increased pressures began, has been found competent to meet every new requirement, and has advanced accordingly.

THE electro-plating of iron with aluminum by a direct process has not been accomplished; but, by first coating either cast- or wrought-iron with copper, aluminum may be deposited upon the copper, and the results, according to *The Metal Worker*, are good. The following description of the process, as carried out at the works of the Tacony Iron and Metal Company in Philadelphia, is extracted from the journal named:

> Six long and deep tanks are used. The article to be plated (in this case a heavy iron column) is placed in tank No. 1, containing a solution of caustic soda, in which it remains 24 hours to clean it of grease. Thence the casting is removed to tank No. 2, where it undergoes pickling for the removal of scale and oxide, remaining 24 hours more. It is then thoroughly cleaned by hand, with steel scratch brushes, preparatory to being placed for a further period of 24 hours in tank No. 3, where it receives a primary deposit of copper. In the fourth tank, to which it is then removed, it receives a very heavy electro deposit of copper, remaining in this tank for 72 hours. This prepares the casting for the reception of its aluminum coating, which is imparted to it in tank No. 5. Here it also rests for 72 hours, an even coating of $\frac{1}{16}$ inch of aluminum being deposited. The last tank to which the plating casting is then removed contains hot water, in which the casting is allowed to remain just long enough to be thoroughly washed. The process is then complete, and the article emerges with a "matt" or dead-white finish of aluminum, which can be burnished at will. The lengthy process detailed above was found necessary for the heavy work done at Tacony, but the principle stands good for smaller castings also, of which a number of specimens have been turned out from those works.

IN a recent number of this Magazine mention was made in this department of the recent great extension of the range of artificial temperatures, both positive and negative, and its possible and probable effect upon the future of the mechanic arts, especially those in which metals are the materials worked. A still further extension of the range has since been announced, the most notable having been effected by the Belgian scientists, Messrs. Lagrange and Hoho, who have succeeded in producing, as they are said to aver, a temperature as high as 8000° Celsius (14432° F.) The method employed by them is extremely simple, and, when considered with reference to the results obtained, would, to most people, appear utterly inadequate. This view was held in the German patent-office, where the application of the inventors for a patent resulted in a demand that they should exhibit the method to a scientific expert before the validity of their claims would be admitted, and this is stated to have resulted in the full confirmation of their stated results.

THE method may be broadly stated to be the passage of a current of electricity through the substance to be heated while the substance—or that part of it which it is desired to heat—is immersed in or surrounded by a film of hydrogen gas, the latter being produced by the electric current simultaneously with the heating of the substance. A vessel of porcelain is lined with lead, and placed in an electric circuit by connecting it with a conductor in such manner that, when the apparatus is at work, it is positive as regards the substance to be heated. The latter is held by tongs with insulated handles, the tongs also being connected so as to form a part of the circuit. Then water, to which a little acid has been added, is placed in the vessel, and the electric circuit is completed by the operator, who, grasping the handles of the insulated tongs, dips the substance, or that part of it which he desires to heat, in the water. The circuit being thus completed, a thin stratum of water is immediately decomposed, the electro-negative oxygen collecting on the electro-positive lead lining of the vessel, while the electro-positive hydrogen collects around the substance to be heated, insulating this from the water by a thin film, which resists the passage of the current to the surrounding water from the substance to be heated so remarkably that the latter is heated to incandescence in an almost incredibly short space of time. Iron is thus brought to a welding heat in a time very much shorter than that required in a forge, and its surface is perfectly clean and in the very best condition for welding. What seems almost magical in this process is the fact that, while the water in close proximity to the heated metal boils immediately when the latter is plunged in it, the mass of the water in the vessel is hardly more than warmed while bringing the metal to a white heat, even though the latter may contain a considerable weight.

MANY are disposed to receive with doubt the statement that on May 9 the locomotive No. 999 of the New York Central railroad ran at the speed of 100 miles an hour, or that on a subsequent date she ran a single mile in 32 seconds, which is at the rate of 112 miles per hour. The statements have been widely accepted and published in the daily press, but those who are competent to judge of such matters are by no means unanimous in giving credence to what been said of this very remarkable performance; for whether the speed claimed to have been made was really achieved or not, the performance was remarkable, as being probably the highest rate of running ever made by a locomotive in a trial of speed. The *American Machinist* at first was inclined to accept the results as stated, but since has seen reason to revoke its opinion expressed at the time, and in its issue of June 1 says that "the information as to this seemed at that writing to be authentic, but since then a good deal of doubt, in which we share, has been thrown on the stated performance. We were misinformed as to the use of the speed-indicator on the engine, for one thing, and a careful consideration of all the conditions make the speed given improbable."

The journal quoted also very sensibly remarks that "fast time in little spurts, or in special instances, is not of much importance. The question that interests the traveling public is how much the time between distant points, as New York and Buffalo, or Chicago, can be shortened."

FURTHER exemplifying the small value of brief exceptional speeds, the *American Machinist* cites an example of a stationary engine with a piston seven inches in diameter that a few years ago was run at a speed of 1300 revolutions per minute, and ran very smoothly, but adds in substance that no one is now building stationary engines to run at that speed. It is presumed that the editor of the paper quoted refers to a reciprocating engine that was built in the now defunct Delamater Iron Works in New York, from designs made by the late John Ericsson. This engine, the only one of the kind known to the editor of this department, was used for running a dynamo that supplied current for electric lights in the foundry. It gave no more trouble than has often been met with in running engines designed for much lower speeds; and if, for any purpose, an engine running at such a speed was not only desirable but essential, there would be plenty of engineers now living who would undertake to supply them, without fear that it would be impracticable to regularly run engines at the desired speed. Whenever there really arises a commercial demand for railway travel at 100 miles per hour, sufficient to warrant the expenditure of time, money, brain, and material necessary to attain it, the demand will be met.

AN announcement of a method of hardening and tempering steel by electricity opens a new lead in mechanical construction, to-wit: localized hardening of surfaces. The method has been originated by MM. Lagrange and Hoho, and is described in *Comptes Rendus*; but the modus operandi is a more appropriate subject for the electrician than the mechanic, as its description involves electrical laws and principles. It will be sufficient here to name the most remarkable of the results, which is the formation of a thin hardened film or skin over the entire outer surface of a piece of steel while the interior remains soft. It is said any degree of hardness in such a film may be attained. New possibilities in the application of such a process will at once suggest themselves to mechanics.

IT daily becomes more evident that we are on the eve of many radical changes in mechanical arts due to new applications of electricity. Some months ago the application of electric welding to pipe-fitting, as a means of avoiding the use of cast-iron fittings, at least partially, was suggested in this department as a field upon which some enterprising electric engineer might enter with a fair prospect of reward. This field is more and more becoming ready for such an innovation, through strong competition in the manufacture of pipe-fittings, the effort to cheapen the cost of fittings having resulted in placing on the market many inferior qualities. It is often difficult to obtain reliable fittings, and steam-fitters throughout the country are frequently embarrassed by discovering defects that can only become apparent to them after the erection of work, thus necessitating doing the work, or a part of it, over again, perhaps only to find that the fittings substituted for those at first found wanting are again defective, and that, while stopping primitive leaks, new ones have been introduced.

AT this writing there seems to be a good prospect that a series of mechanical tests, recommended by the American Society of Mechanical Engineers, will be made the basis of awards at the World's Columbian Exposition. There appears to be almost a unanimous expression of opinion favorable to the carrying out of these tests under the direction of recognized experts, not only on the part of engineers generally, but also among the exhibitors. Apart from any commercial interest that may influence the views of exhibitors, it is seen that such a series of tests, performed by able specialists who have the public confidence, must result in the publication of reports whose instructive value can scarcely be over-estimated.

THE trial trip of the new United States armored cruiser *New York*, which was made on May 22, has been, perhaps, the greatest event in marine engineering since the matter for the last number of this Magazine was in press. There is no doubt that this vessel represents all that is best in naval construction and armament, and she is probably entitled to rank among the fastest war-ships, if not as the fastest afloat. At any rate, the speed developed on the trial trip, 21 knots an hour, is a gait very hard to overtake or to run away from. The excellent performance of the engines, still new, through so severe a test, prolonged for a period of four hours, shows a superior character both in design and construction. In short, all the machinery and the outfit are of most approved kinds. Among the machinery the air-pumps are worthy of mention as being of special design and proving remarkably efficient. It was, doubtless, owing in some measure to the excellent vacuum maintained by the air-pumps that the power of the engines proved equal to the demands made upon them during the trial. These pumps as well as the entire outfit of pumps used on the ship were supplied by the George F. Blake Manufacturing Company, of New York. It would be unadvisable to occupy space here with such a meager description of the details of the engines as could be given in the space available. The result of the trial has not only demonstrated the excellence of the ship in all material points, but it will entitle the eminent constructors to a very handsome premium, to which, in view of the published results, the country at large will think them well entitled.

LOCOMOTIVE engines were run successfully at high speeds at a time when it was generally thought entirely impracticable to run stationary engines of equal size at similar speeds. No longer ago than 1876 the writer had an argument with an engineer of high attainments and considerable achievement, who took the ground that for some unknown reason a locomotive could make more turns in a given time than any stationary engine that had been or could be built, without giving trouble by heated bearings, etc. The position taken seemed absurd, when the difference in the working conditions was considered, which, from an engineering standpoint, seem far more favorable to the stationary engine running on a solid foundation in a cleanly power-house, or engine-room, always on a level base, and in perfect alignment, whereas the locomotive is continually surging from side to side, changing the level of its base, and running often through clouds of dust, difficult to exclude wholly from bearings. The fact remains that for many years locomotive engines led the van in the matter of high-speed running. The reason appears to have been that the high speed was so imperatively demanded that the necessary efforts to get it were put forth. So far in the history of mechanical progress sufficient demand has secured sufficient supply, and there is no reason to believe that it will be otherwise in the future.

THE creosoting of railway-cars bodily after they are built is one of the latest attempted innovations. The experiment, said to have been entirely successful, has been carried on in England, and has been described, more at length than it can be in this department, in *Industries* (London). A large cylindrical chamber of boiler-iron is employed, and this is placed on its side, in which position the car to be creosoted may be run into it from a track arranged so that it meets a short track laid in the lower part of the cylinder. The open end through which the car has been run in is then closed by a swinging door which is fitted to a flange, to which, when closed, the margin of the door is clamped. Under the cylindrical chambers are placed receptacles for the antiseptic fluid, and by pumping out the air from the chamber the liquid is forced, under atmospheric pressure, up from the reservoirs into the creosoting chamber. Glass gages indicate the height of the liquid in the chamber. A pressure gage is connected with the cylinder, the latter being constructed to withstand safely a pressure of 100 pounds to the square inch; and a safety valve, connected with an air-space in the upper part of the apparatus, is used to limit the pressure to that named. Under this pressure the liquid is forced into the pores of the wood, and the car is allowed to remain several hours in the chamber to thoroughly complete the process. The apparatus is so arranged that the droppings of liquid, when the car is taken out, run back into the lower receptacles. It is easily seen that a large saving of the antiseptic fluid results from the treatment of the completed structure rather than the lumber before it is worked, as, in the latter case, all the waste in construction will represent a proportional waste of the liquid. Whether this saving will compensate for the increased cost of apparatus and manipulation sufficiently to render the treatment of the completed cars profitable is a yet unanswered question.

A NEW drawing-pen which is claimed to contain the promise and potency of great convenience in the drawing-rooms of mechanical establishments has been invented, and is now placed on the market by a firm in Leeds, England. It appears to have occurred to some one that the convenience of the now extensively used fountain-pen in ordinary writing might be attained analogously in a fountain-drawing-pen. The fountain consists of a cylinder containing the ink and forming the handle of the pen. A small tube reaches from the hollow handle down into the space between the nibs of the pen, which are of the same form as the common ruling pen. To supply the nibs with ink the latter is forced through the tube by pressure upon a small plunger fitted to work in the cavity of the handle, which is operated whenever the ink is wanted. The ink is drawn into the hollow handle exactly as water is drawn into the barrel of a syringe by the reverse action of the plunger, and when it is filled it is said to contain ink for several hours' use.

THAT there are dialects in technology, as well as in the ordinary language of business and conversation, any one may convince himself who will take the trouble to compare the various vocabularies of mechanical terms and phrases in use by different trades in different countries speaking the same language, and even in different parts of one country. The number of such terms is constantly increasing, keeping pace with the introduction of new machinery and processes. One difficulty Americans meet in reading works upon industrial subjects published in England is the occurrence of such terms without explanation either expressly, or by implication in the context; yet these terms, when their definition is found, often turn out to mean something quite well known to the reader, who has been accustomed to hear it called by another name. If some author would supply a complete dictionary of technical English terms, taking pains to collect all local synonyms, with copious cross-references, up to date, it would be very useful.

THE effort to secure an increase of production without corresponding increase of cost is commendable in and of itself, and it has resulted in a much larger output, measured in quantity, from most modern establishments. But to what can the notable deterioration in the quality of manufactured articles be attributed, if not to the effort to compete by cheapening products regardless of quality? A very large proportion of all lines of goods now placed on the market are inferior to articles of their kind as made twenty, or even ten, years ago. There must be some limit to the extent to which cheapening by deterioration and adulteration can be carried. It is true that manufacturers may justly excuse themselves by the assertion that they must make what the public demands, and that more and more the public demands cheaper articles, and is willing to put up with inferiority if by so doing first cost can be reduced. It is hard to find any answer to this argument. The manufacturers make out a good case as between themselves and the majority of their customers. The desire for outside display, even at the sacrifice of intrinsic worth, that pervades modern society is at the root of this as it is of many other evils. When the cheap and nasty ceases to be sought by purchasers, it will no longer be placed on the market. The misfortune is that manufacturers have contrived to finish things that are inferior in such a way that they simulate in outside appearance that which is really good. Those who would continue to make really good articles may, perhaps, initiate a reform by adopting a plainer style of finish, such that its imitation cannot disguise defects.

OF that class of mechanical drawings commonly classed in the category of sketches, or such as are not drawn to an exact scale, and in which the guide to proportions of parts is, therefore, solely such dimensions as are given in figures by draftsmen, Mr. Walter B. Snow has made useful suggestions, which he has communicated to the *American Machinist*. He recommends the use of letter-size paper and an aniline pencil for making the drawings, and their duplication by copying, in the same way as letters are copied. Four or five copies can thus be made, and one of them mounted on cardboard may be used in the shop, while the original can be sent to a customer to guide him in setting up or applying the thing ordered. Another copy may be retained for the office records. In "hurry jobs" a great deal of time can be thus saved that would be required for blue printing, especially in a cloudy and dark day. A special series of copying books could be used for these sketches, which, as Mr. Snow points out, would be particularly convenient in the suggestions and preliminary sketches that so often pass before an order results.

ARCHITECTURE.

Conducted by Barr Ferree.

THE uselessness of architectural competitions never had a finer illustration than in that which the Brooklyn Institute of Arts and Sciences lately set on foot for a new museum building in Prospect Park, Brooklyn, and which has now come to an end. This competition was more than usually remarkable in several ways. It was instituted, in the first place, at the instigation of a body of architects, who formally set their approval upon the competitive method as the very best way of obtaining the very best building. How far they were right remains to be seen, for a museum building is necessarily of so complex a nature that only after it has been in use for some time and its capacity tested, as well as its adaptability, can its full success be measured. The competition was further peculiar in calling for the accommodation of an institution numbering practically some twenty-five or more distinct scientific and literary societies, all with their own collections and apparatus, and all needing distinctively individual rooms. The program was necessarily an extremely complicated one, and the competing architects must have had to devote many hours of study to it in order to prepare themselves for the task of design. This complexity was, of course, a circumstance over which none of them had any control, since it was an essential element of the problem ; but, admitting this to be the case, the fact remains that only by an extraordinary distortion of the value of a competition could seven or eight architects—the final number in the competition—have been put down to study the long list of details. To comprehend the building aright one should have been a museum expert, which few architects pretend to be. But the professional judgment of those responsible for the competition was that their body included a number of museum experts, and the great trial began. A limited number of architects of the first rank were selected from the architectural members of the Institute, all of them, presumably, of equal capacity for carrying out the work, and any one of whom, it may further be surmised, would have been equally satisfactory and congenial to the Institute authorities. In due process of time it was found that the most eminent of the competitors was adjudged as having presented the most successful design, though the jury of experts, strangely enough, admitted that its chief merit was that it could be changed in any sort of way without entirely destroying it. There is little doubt that the same eminent firm that won this competition would have been selected to undertake the work if there had been no competition, and if eminence had been a desirable standard of value. The whole architectural profession, as well as the unsuccessful competitors, may well ask themselves, if such was the case, why should a competition have been held? The result was just what it would have been without the competition ; wherefore its use ?

THE most interesting feature of the Brooklyn museum competition—it cannot be called surprising, since it is just what might have been expected—has been the extent to which the work of the younger men exceeded that of the older. The three most notable designs submitted were shown by Mr. Albert E. Parfitt, Mr. Albert L. Brockway, and Messrs. Boring and Tilton, all young men, and all showing designs of more than ordinary merit. Mr. Brockway's design exhibited an exceedingly clever façade, that told, as well as any façade could, that it was the front of a museum. The plan, however, was not as well carried out as some of the others. In Messrs. Boring and Tilton's design the opposite conditions prevailed, the plan being admirably studied while the façade was less satisfactory—to place it in comparison with a thoroughly good example—than Mr. Brockway's. The management of the roofs, while very Ecole, was labored, and the dome far from effective. Neither of these criticisms can be made of Mr. Parfitt's design, which was clearly the best of the seven submitted, and we see no reason at all why he should not have obtained the prize of the award. The plan was studied with great care and with the nicest perception of the uses to which the rooms and courts were to be put. Alone of all the plans it included a monumental staircase of magnificent proportions, which, while it interfered with a view from one end of the building to the other, was so admirably thought out and artistically planned as to more than compensate for the loss of a vista. The design of the façade was both effective and beautiful. The central feature was a triumphal arch, of fine proportions, buttressed by two sturdy pavilions. A colonnade twenty-eight feet high, introduced in the third story, formed the chief feature of the wings, which, in their turn, were buttressed at either end by broad piers of masonry. The whole design was dominated by a dome, of sufficient size to be well seen in perspective,—surely a most necessary requirement in a dome. Well balanced, duly proportioned to the duties assigned to each part, this design was, in our opinion, entitled to be placed first. It was a noble conception, admirably conceived and as admirably carried out. The author—who, by the way, is a young Brooklyn architect—may rest assured, however, that he has produced one of the most notable designs of the year, a work that he can always look back to with pride, and which, more than anything he has yet done, will be a good big stone in the foundation of a reputation that must grow largely every year.

IT is unquestionably the greatest misfortune of current architecture that the high office building was not invented in the sixteenth century. Had this been the case, we would not now be groping in the dark, each man trying his own individual ideas to the great discomfort of those who are daily forced to look at his work, and, in the lack of homogeneity which such procedure entails, to the lasting retardation of the art. If modern architects had precedents three hundred years old to help them in the design of their office buildings, most likely we should not only have better structures than we have now, but we should be saved the necessity of labelling structures Italian which are totally unlike anything in Italy, and whose chief Italian characteristics exist only in the mind of the designer or the draftsman. A few weeks ago the metropolitan newspapers seemed to be afflicted with a sort of architectural contagion, since panegyrics on the merits of a new office building for the Manhattan Life Insurance Company in New York appeared simultaneously in several of them. As an example of loose nomenclature and the methods employed in designing high structures this edifice is a very fair sample. From the sidewalk to the top of the dome is the astonishing distance of 317 feet. As the width of the building is but 67 feet, the advantages of the Italian renaissance, which, we are told, has been selected for the building,—and which by nature and by application was a style of architecture peculiarly adapted to width and broad surfaces,—are very far from being obvious. In the sixteen stories forming the central portion of the front no part is more than three stories high, the architect having diversified the scenery as he mounts skywards either by friezes or strings, or by wholly changing the character of the architecture. When to these horizontal changes are added a few vertical ones, and a dome and its supporting story are added, it is obvious, without the help of a picture, that a great many ideas, or attempts at ideas, are contained in this great front. The completion of this structure will be watched with interest because it is, in some respects, the most notable application of the New York horizontal-afraid-to-build-high, variegated style of designing high office buildings.

THE "practical politicians" who make up the body of the governing corporations in our seaboard cities will find fruitful subject for reflection—if the faculty has not been obscured through lack of practice—in the little book on Berlin written by James Pollard, Esq., chairman of the Edinburgh public health committee, and secretary of the Edinburgh chamber of commerce, and entitled "A Study in Municipal Government." Mr. Pollard set forth with the admirable intention of telling his fellow-townsmen how they managed things in a well-ordered city on the continent, and the result of his observations might well be studied by municipal managers in America. The great trouble with American municipal government is the lack of homogeneity in the growth of great cities. Each city starts out independently and on a better plan than any other, and yet with very little thought of profiting by the experiences of older ones. American politicians are apt to plume themselves on the advances they have made in their own departments, and some even go so far as to point with pride to the growth of their particular city. Yet with all our boasted progress the fact remains that the best governed cities, the most ably developed and thoroughly broadened municipalities, are the old cities of the new world, in which the necessity for new growth and complete change from the old have been so wholly recognized as to compel the introduction of a new order of affairs. Nothing of the sort is to be seen in even the most active communities in America. New York cannot annex other districts because local politicians interpose objections which have no foundation save their own selfishness. Boston is hemmed in with so-called rival municipalities that hug their civic privileges and imagined independence with absurd pretensions of might and power. Philadelphia has, in truth, added vastly to her territory and stands quite distinct among seaboard cities in this respect, but she is wanting in the metropolitan spirit and capability of development which alone would make this increase of territory valuable. In the west a different feeling may be noted, and this, as well as their more rapid rate of increase, tends to make our western cities more prosperous, as well as more modern, than our eastern.

FEW municipal officers in America would have taken the trouble to write a book on a foreign city, such as Mr. Pollard has done, and few—to our lasting disgrace—would have been capable of making the observations he has made. Yet it is only by the comparative study of municipalities, a critical noting of their peculiarities and characteristics, and an insight into their methods, that other cities can grow and keep pace with the times. The conditions of city life are so little appreciated by modern philosophers that the astonishing fact that the making of a modern city consists chiefly in undoing what has been done before is scarcely recognized in the books. Yet is the making of a modern city anything but this? Are we not continually taking up the pavements of city streets to put down something new, or remodeling our city plans, or taking down houses and shops that new ones may be erected on later and more improved plans? At least we think we do, though often the improvement is more theoretical than real. There is too much carelessness in American city-making, too much slipshod work, too little unity and singleness of purpose. Quite the contrary has been the case with Berlin, which, just after the close of the war of 1871, was one of the vilest and most unsanitary cities in Germany. The poor were confined to basements or top stories of tenements, to cellars, or similarly unhealthy places. As many as 4565 dwellings were without any fireplaces whatever, while 95,000 dwellings had only one room with a fire-place. Many other worse conditions existed, but this is sufficient to indicate the abominable condition of the city. The energy with which a single eminent man of science, Professor Virchow, devoted himself to the task of reformation has made Berlin one of the most admirably maintained cities in Europe, with a death-rate that has decreased from 30 to about 20 per 1000, and is expected to be further reduced. It would require more space than can here be given to it to even briefly catalogue the changes and improvements necessary to produce this result, which was brought about, first of all, through the energy of an extremely able man, and, secondly, through the vigor with which the corporation applied itself to the work of reformation and cure. There was little "politics" in this work, but those most active in it have reared for themselves a monument that will last while there are tongues to tell of it or scribes to set it down in writing. The picture, as Mr. Pollard has drawn it, is an interesting and an impressive one. Would that the governing bodies in our American cities would feel called upon to follow the same path.

THE articles on architecture which appeared in *Scribner's Magazine* three years ago have just been collected in a book. This seems an unusual length of time to have elapsed, and it is a pity it was permitted, since, while the value of the text remains the same, the value of the illustrations as examples of current work has greatly diminished. Not that the houses they show are less beautiful,—when presented as illustrations of the beautiful,—but domestic architecture has progressed a good deal in the last three years, and the illustrations are, therefore, totally inadequate as helps to an opinion on current work, while the further fact that the date of the original appearance of these papers is not so much as hinted in the book is likely to lead forgetful readers astray. It was a further misfortune for the publishers to have announced the papers in the volume to be by "six eminent authors." Both words are, perhaps, of difficult definition, but a man can be an eminent architect without being in the least qualified to act as an eminent author, and the converse rule is equally true. Of the six contributors to the volume only one, Mr. Russell Sturgis, can rightly be called an eminent author, the others, including Mr. John W. Root, Mr. Bruce Price, Mr. Donald G. Mitchell, Mr. Samuel Parsons, Jr., and W. A. Linn, being, with the exception of Mr. Mitchell, better known for the work they have done in other fields than that of literature. Doubtless this looseness of speech—or should it be called looseness of advertising?—is a matter of no great consequence, but in a book of so serious an import as this it is a pity that everything connected with it should not be entirely in order. Further exception might be taken to the title. "Homes in City and Country" has a homelike, ordinary flavor suggestive of quiet domestic happiness, yet nearly all the contributors deal more with the ornamental and ceremonial aspects of a house than with its domestic possibilities and characteristics. Mr. Sturgis, for example, who presents an historical sketch—unhappily only too brief—of the development of the city house in the east, has very little to say concerning kitchens, cupboards, cellars, furnaces, heating, and the thousand and one details which go to make a home, though he is very much disturbed indeed if the butcher-boy happens to make his call while the mistress of the house is entertaining her guests, or should happen to deposit his meat-basket within a foot or two of or—horror of horrors!—perhaps upon the very doorstep which the sacred foot of a guest must pass in order to gain entrance. All of this is very instructive, and some of it not a little amusing, but surely a successful home—if that be the proper adjective—is not the most so because its owners can most freely yet ceremoniously entertain their guests.

With the exception of the historical part of Mr. Sturgis's paper the most interesting part of the book is the study of the city house in the west by the late John W. Root. As might be expected from one whose successes in life were gained in the west, Mr. Root is full of enthusiasm for the life there and its architecture. Eastern critics, perhaps, may not always be willing to give credence to the architectural revival in the west, but it unquestionably exists, just as it is unquestionably far in advance of any similar movement in the east. In some respects the west has had more to unlearn in architecture than the east. Its earliest development was full of horrors of every description, all of which must be forgotten and destroyed before a permanent reform can be effected. This is already in fair way of being accomplished. The crudities and excrescences which, a few years ago, passed for architecture in the west are no longer to be seen, save in ancient examples. The inferior quality of this old work was so marked that not only has a new school now arisen, but the old work is so generally recognized as bad that it is destroyed to make room for better and purer work. And this is not only architecturally more interesting than the old, but it is of better workmanship and is destined to last, not only for its own inherent permanency of construction, but from its architectural grace and beauty. The west has a further advantage from the openness with which nearly all western cities are erected. The country house is the one form of architecture which American architects seem to have most clearly comprehended. And this not so much from the simplicity of the problem as from the frequency with which it is presented. The city house of the west, unlike its prototype of the east, is more a suburban residence than the solid stern structure built in rows in the east. There are freer opportunities for architectural treatment, and with less confined limitations the architect manages on this account to produce a much more pleasing result than with solid blocks of dwellings, each of the size and apparently all designed for the same occupant. The suburban and country house is further treated by Mr. Bruce Price, Mr. Donald G. Mitchell, and Mr. Samuel Parsons, Jr., thus occupying much the larger part of the book. The concluding paper by Mr. Linn on "Building and Loan Associations" is quite different in subject matter than the other papers in the volume, though it treats more of the home than they do.

THE bestowal of the Royal gold medal of the Royal Institute of British Architects upon Mr. Richard Morris Hunt, of New York, which took place in London during the past month, was an event of unusual significance. Not only was Mr. Hunt personally honored in being given this decoration, but it was at the same time a high tribute to American architects and American architecture by the leading professional body of Great Britain. American architecture has been so long looked upon by reputable English architects as a hybrid distorted product that this professional courtesy is of the utmost significance in indicating the solid foundation of merit which exists in the art in this country. The presentation of the medal shows, therefore, that not only has American architecture progressed to a point where it can be profitably and honorably compared with the best of older countries, but that the most exclusive people, architecturally, are willing and glad to admit this fact. No greater compliment has ever been paid to American architecture than in the ceremony of which Mr. Hunt was the chief figure. He himself does not need our words of praise to do him honor. His long life has been devoted to the noblest art in the noblest manner. He stands for all that is good and truthful in American architecture, and when this has been said there is little more that need be added. No man has more firmly impressed his personality upon the architecture of this country than has Mr. Hunt. Richardson did, indeed, inaugurate a school that has made itself felt for years after his death. But the fundamental element of Richardson's art was exaggeration and a venturing forth into new fields. Mr. Hunt's influence, on the contrary, has been towards restraint. Not a single example of his work is characterized by that striving after effects which Richardson himself often fell into and which his followers exaggerated to an intolerable degree. There is, in truth, no need to compare the two men; each had his work to do and each did it to the fullest of his ability. Fortunately for architecture in this country Mr. Hunt's work is not yet done.

MINING AND METALLURGY.

Conducted by Albert Williams, Jr.

ANNUAL meetings of English mining companies, as reported in the English technical journals, are a constant source of wonderment to American readers. They also have some features that are well worthy of imitation in the United States, where these meetings are perfunctory performances, the shareholders being mostly represented by proxies, and the business rushed through on a cut-and-dried system, the few persons in attendance voting in or out the directory and approving or disapproving the policy of the management, solely in accordance with the proportion of shares represented on one side or the other, which balance of power has been ascertained in advance. Practically the minority in American companies have no say at all in these meetings. If they don't like the way in which the company's affairs are managed, they stay away from the meeting, and, if the case is urgent, rely on the dubious interposition of the courts for redress. In the annual meetings of English mining companies, according to the reports, all is different, and sometimes amusing. There is generally a large attendance of the small shareholders; there is an M. P., a distinguished general or admiral, or at least a titled figurehead of some sort, in the chair, who reads a minute and lengthy statement of the operations of the company for the year, and at the close of each of his paragraphs pauses to allow time for the British reporter to patriotically add in parentheses, "hear, hear," "applause," or "loud applause." But there is a serious side to these formalities, verbosities, and long-windedness. The audience is large and deeply interested. Questions are asked and answered; the freest debate is allowed on doubtful points; the listeners come to the meeting with a desire to find out the true status of their investments, and are by no means backward in pushing their interrogatories. As a rule the shareholders are (like their cousins in the Eastern States of this country) profoundly ignorant of the technical phases of mining; but "they want to know," as they certainly have a right to demand, what is being done with their property and their money. This jealous watching of interests is a potent, though often misdirected, factor. But it would be well for American companies if the same amount of interest could be aroused.

LATELY there was held in London the annual meeting of a company operating mines in Montana. The chairman (or, as we should call him here, the president of the board of directors) read the reports of the superintendent, the treasurer, etc., and as usual made a speech. The company had made money, but there were no dividends. It seemed that the management rather discredited the existing properties of the company, and proposed to buy up new claims to provide an ore-supply for their mill. Then there was a commotion. It was shown that the chairman (who had been liberally paid for a trip to and examination of the property) was, with other directors, interested directly in the locations which it was proposed to take up. At this stage of the proceedings American shareholders would have paused to count up their strength. Not so the Britishers. The resignation of the chairman and a part of the directory was promptly demanded and acceded to; new officers were voted in; and the meeting proceeded, somewhat irregularly, and perhaps illegally, but very determinedly, to establish things on a new basis, very much like that ensuing on a cabinet downfall after a vote of confidence has been lost. What the merits of the case were in this instance we have no means of knowing. But there is a lesson in it.

As is usual in international exhibitions, there is now the customary fault-finding from various sources about the mineral display at the World's Fair. Considerable local jealousy has been aroused, State against State and Territory against Territory, even county against county and district against district. But all this feeling has acted as a stimulus in inciting each part of the country, and each foreign country, to make a good showing. It is not possible to please everybody. Ninety-nine people out of a hundred who visit the World's Columbian Exposition are better pleased with the showy, catchy display of fancy ores and minerals than with the scientific features. The few experts demand something more solid,—systematic collections of measurable value. It is hard to satisfy both classes, and, until some one has adjudicated the vexed question of what the great Fair is for, after all, it is the best policy to give all visitors their choice. At present there is a current of adverse criticism, but it is somewhat mixed and contradictory. The mayor of Denver, for example, says that the Colorado collection is too "scientific." Probably he wants more silver and silver-plated statues, more pyramids of showy ore, more gilded bricks and obelisks, and what the *Mining Industry* (Denver) calls "a pagoda, Joss-house, or imitation palace," to cover it all in. The majority indeed seem to favor the dime-museum idea. On the other hand, the professional miners and metallurgists would like to see a systematic arrangement that would convey some information of what is being done and what the resources are in various parts of this and other countries. So far as we can make out, without personal inspection as yet, this feature—the one which will be prominent in the minds of thoughtful visitors—has been mostly disregarded, though a few exceptions are described. There has been no lack of money to collect and exhibit the mineral treasures of the mining States, and there has been plenty of time to organize. Of course there have been mistakes in the selection of men and methods, and a considerable waste of public money. It is rather too late to attempt to correct former errors now, though some of the States are still trying to get together further supplemental collections, for which the floor space of the mines building is probably inadequate. Colorado and California have been especially disappointed in their exhibits, though abundant means were provided and there was plenty of public spirit among the miners and metallurgists.

In spite of all failures and disappointments, in spite too of a disagreeable element of vulgarity and tawdriness, the mining exhibit in its entirety is certainly a great one.

A MODEL exhibit at Chicago is that of the Bethlehem steel works in the Manufactures building. The catalogue shows only about a dozen pieces, but they represent the various stages of production of gun and armor-plate forgings in an intelligible and instructive manner—just as they look in the works, without adventitious aids from finish and decoration—and two steam-hammers as illustrative of the tools used in steel metallurgy. Exhibits like this, of which there are other examples, are of real educational utility, and there are always enough sensible people to appreciate them.

COMPARISONS may be odious, but one feels impelled to enter a mild protest against an expression used by Mr. Thomas E. Brown, Jr., in his admirable paper on "The American Passenger Elevator" in the June ENGINEERING MAGAZINE, referring to "the crude mechanisms for hoisting, such as are used in mine-shafts." Something should be allowed for difference in conditions. Modern practice demands high speeds in lowering and hoisting in deep vertical shafts, these speeds often ranging from 1000 to 3000 feet per minute, and, though it is usual to run the mine-cages at lower speeds when carrying men than when loaded with coal-, ore-, and rock-cars or empty, still in the big mines they move with a velocity something like that of a railway train. It is not possible to keep the shaft timbers and guides in perfect alignment; the additional great dead weight of cable in deep shafts has to be considered; the underground loading and unloading have to be done with the disadvantage of poor light, mechanical or electrical uncertainties as to signalling; often dripping water, vitiated air, steam and heat to disconcert the men; and more important than all, it is economically impracticable to introduce all the refinements which are possible in the construction of passenger lifts at the surface. Yet, notwithstanding all the disadvantages of conditions, shaft accidents in mines where cages are used have been reduced to very low percentages. There is a record of 6,000,000 individual trips of men up and down 1200 feet in an English colliery at the usual speeds without the slightest accident, and doubtless many similar records could be produced. A fatality such as that which occurred lately at the Calumet and Hecla mine, where ten men were killed by the overwinding of a cage, consequent breakage of the cable-couplings, and fall of the cage and men back into the shaft mouth and to the bottom, is now a very rare occurrence. An immense amount of mechanical ingenuity has been brought to bear upon the hoisting problem, and any one who has studied the most advanced practice cannot fail to be impressed with the results. There are now three-decker cages capable of carrying twenty-four to thirty men, and running safely at considerable speed; there are safeties against falling; automatic chairs; detaching hooks and automatic throttles to prevent overwinding; powerful brakes, controlable and automatic; position indicators and alarms; safety hoods; flat-woven and round-tapered steel-wire cables of the finest material and workmanship; balanced cages, tailropes, etc.; and, in short, almost every imaginable device to insure the safety of the men, except an efficient guard against their swaying out and being caught by the timbers, which is now the most fruitful cause of cage accidents, and which seems difficult to adopt without interference with convenient working. The accidents which do occur are mostly attributable to carelessness, just as with the passenger elevators. The mine-cages cannot have the same safety devices as the elevators, nor have they marquetry sides and parquetry floors, plate mirrors, plush sofas, tapestries, rugs, flowers, and tinted incandescents; but, allowing for difference of conditions, as just suggested, they are fairly satisfactory, both as to efficiency and safety.

In an incidental mention of iridium metallurgy, in a paragraph which appeared in this Department in the June issue, unintentional injustice was done by the omission of mention of the work of Mr. John Holland, of Cincinnati, who, after eighteen years' study and experiment and a large expenditure of money, succeeded in 1882 in fusing the metal with phosphorus in a common draft furnace. Since then Mr. Holland has melted as much as twenty ounces in one crucible at a time, and molded it as easily, he writes, as silver or gold. This of course does not detract from the credit due Professor Dudley, who became associated with Mr. Holland, and who discovered the method of electroplating with iridium and made valuable researches on the behavior of the formerly so refractory metal.

Near Crescent City, on the coast of northern California, a plant has been put up for the electro-magnetic separation of iron ore from the black sands of the beach. It is expected to handle 1000 tons of sand daily, and it is claimed that the crude sand carries 10 per cent. iron, which would give a product of nearly 100 tons of pig daily when smelted. Similar operations in other places have been only partially successful, but the black sands of the Pacific coast are unusually plentiful and rich. We would have more faith in the present venture if it were not yoked to a somewhat mysterious smelting process.

The Carson mint, which was closed for coinage on June 1, is one of the most modern and best-equipped plants of its kind in the world. It was established for the purpose of handling the Comstock bullion at a time when the output of the lode was large enough to warrant it. The latest policy of the treasury department has been to concentrate the refining and coinage of bullion at a few principal points, leaving the "branch mints," so-called, to serve as depositories and assay offices for amalgam, dust, and gold and silver bullion.

It has always been recognized that for desulphurizing and chloridizing ores no better work could be done than in the long hearth reverberatories. But these, when operated by hand, while giving a dead roast or a high degree of chloridation, are slow, of low duty, and require much labor and consequent expense, while their efficiency depends largely upon the skill and faithfulness of the manipulators. The O'Harra mechanical reverberatory, introduced many years ago, was an attempt in the right direction, to place the old reverberatory on a level with the revolving shaft and shell roasting furnaces by substituting mechanical stirring appliances for hand rabbling. These were plow-stirrers drawn by a chain over the double hearths; but certain disadvantages were due to the friction of the stirrers on the brick floors and the injurious effect of the heat and sulphurous fumes upon the mechanism. Now important modifications have been introduced in a new form of furnace, called the Brown-Allen O'Harra, in which the carriers are wheels running upon iron rails at the sides of the furnace and to a great extent protected from the heat and fumes of the working hearth by slotted brick partitions. The stirrers are moved by a transverse rigid traveling bar, which holds them just clear of the hearth floor. Thus the friction is much reduced, the iron mechanism fairly protected, and the duty of the furnace correspondingly increased.

MOVEMENTS are on foot in various localities in the Western mining regions and at points near new mining districts to build lead-smelting plants, and not always with the soundest judgment. The history of the many ill-considered attempts at lead-smelting for the precious metals at badly selected sites in the past ought to serve as a warning. The successful plants of this kind are for the most part placed, not at or even very near the mines, sometimes indeed at very long distances from them. Their sites have been chosen with reference to the best total average of all the conditions of transportation, supplies of ores, fuel and flux, and markets. The most economical and proportionately best-paying works are also conducted on the very large scale necessitated by sharp competition. To attempt to establish smaller plants at places where only one or two out of the many basal conditions are favorable—say proximity to the ore-supply, for instance—is a very hazardous undertaking. Even as to ore, quantity alone is not sufficient for successful working, unless in the improbable event of a continuous supply of neutral or easily fluxed ore. Success depends upon skilfully adjusted combinations and mixtures. Lead-smelting for the precious metals does not stand on the same basis as copper-matte smelting or the pyritic-smelting processes, which aim simply to turn out an unfinished material for shipment to better placed works for further reduction, and should be rather viewed as concentrating methods. It is a most complex industry, requiring not only large capital but also the highest technical and commercial skill and forethought in taking advantage of existing conditions. Of all the many considerations to be taken into account in planning new works, the question of site is or ought to be the most decisive. Unfortunately the indications are that this crucial point is not always clearly appreciated, and possibly there may be from this cause a temporary retrogression in silver-lead metallurgy.

IN a contribution to the *American Antiquarian* Mr. R. L. Packard presents the results of an extensive investigation into "Pre-Columbian Copper Mining in North America," and brings together all the evidence from the records of early explorers, Indian traditions, personal observation and that of other recent observers, summing it up for the first time from a combined archæological, mining, and metallurgical point of view. There is no reason to believe that the old copper miners were of very remote antiquity or possessed of extraordinary skill and a relatively high degree of civilization, as has been often claimed for them. The northern Indians had no knowledge of smelting ores (as did the Aztecs) or even of melting and molding the native metal, but were content to hammer into shape such piece of native copper as they could find. Still less were they acquainted with bronze. The total stock of aboriginal copper ornaments, implements, and weapons was very small. "Modern miners," Mr. Packard says, "would consider the whole system nothing more than prospecting, and not mining proper, as there were no shafts or tunnels or underground workings of any kind." As Mr. Whittlesey expressed it, "the old miners performed the part of surface explorers." Mr. Packard remarks that "native copper occurs in small quantities in many places in the United States, but there is no evidence at present that the northern Indians had knowledge of any but two localities where it could be obtained in any quantity. These were the Coppermine river in the British possessions and the Lake Superior district. The latter affords the most remarkable occurrence of native copper in the world."

WHAT is the Armstrong hoister? That is a question which puzzled a mining man who thought himself fairly posted on mining machinery. He was somewhat abashed to find it to be simply the hand-windlass of antiquity. The expression is not very common, but it is good.

The writer remembers once asking quite innocently, on reading an account of a mining accident, how it happened that "scales" should be allowed to fall down a shaft and kill men working at the bottom. He has not yet recovered from the answer and the laugh provoked by that inquiry.

There is a gold-mining district out West where the ore is partly free and partly auriferous sulphides. The miners there call everything "tailings" that passes the battery and plate amalgamation, including the concentrates, which are often the most important portion of the product. It is not a little astonishing to outsiders to hear or read in the local production returns of "tailings" worth $30 and $50 a ton being shipped to the smelters.

Several good glossaries of mining terms have been prepared, but it is impossible to compile in them all the current local expressions and keep up with the new ones. A man who should try to learn them all would find that he had undertaken a large contract. In American mines may be found miners of every nationality, representing a multitude of districts and bringing with them their own peculiarities of habit and diction. The mining vocabulary borrows from all sources indifferently,—Cornish, North of England, and other dialects of Great Britain; from the Hartz, because so many of our engineers have been educated in Germany and because German mining literature has had so great influence; from Spanish-American countries, since in the early days of silver-mining in the United States the Mexicans and Chilenos were regarded as authorities; and in less degree from other foreign sources. In general, there is a broad distinction between the terms used in coal-mining and those common in metal-mining. But, besides all this, almost every camp offers some original localisms of its own, while novel circumstances and new appliances constantly enrich (and confuse) the vocabulary with fresh additions. Probably few miners unfamiliar with the Comstock could guess what sort of thing a "buckboard" is, or a "giraffe," and it would be possible to pick out scores of similar conundrums from local usages. Without going into foreign words at all, the English language (or rather this subdivision of it) contains enough mining synonyms and odd expressions, in common use in one or another of the many districts of the old country, the United States, and Australia and the other colonies, to be sufficiently bothersome, and also instructive as showing what twists a language is capable of.

"THE Mineral Industry, its Statistics, Technology, and Trade, in the United

States and Other Countries," is the title of a recent book compiled by Mr. Richard P. Rothwell, editor of the *Engineering and Mining Journal*, of New York. It is designated as Vol. I. of a proposed annual series, and carries the statistics or estimates down to the close of the calendar year 1892. The book is a large octavo of 628 pages. Its title sufficiently indicates its scope, which is an extension of the annual reviews of the mineral industry previously published in special editions of the *Engineering and Mining Journal*, issued early in each year to cover the history of the preceding year. In the statistics Mr. Rothwell has brought together the results of the eleventh census, the work of the geological survey, the bureau of statistics of the treasury department, the bureau of the mint, the Iron and Steel Association, etc., with modifications; and for 1892, in addition to the usual and generally accessible trade reports for iron, steel, anthracite, quicksilver, petroleum, and the gold and silver statistics of the mint officials, has added the results of an extensive original canvass of the various branches of the industry. Among the names of the gentlemen credited with the preparation of separate chapters are those of several well-known specialists. The enterprise shown in undertaking a publication of this magnitude is highly commendable, and the comparative promptness with which the results have been presented to the public is especially creditable.

Simultaneously with the issue of "The Mineral Industry" appeared "Mineral Resources of the United States," for 1891, the eighth volume of the series prepared by the Division of Mining Statistics and Technology of the United States Geological Survey—an octavo of 630 pages. While it is fair to state that the production figures compiled for 1891 by the Geological Survey have been before the public for many months in the shape of advance bulletins and statistical charts, it cannot but be regretted that the publication of the complete report was so long delayed. It has had the advantage of better facilities, the prestige and authority of a government work, and better (though still insufficient) means in money and men to carry out the necessary canvass than obtain with a private undertaking. *Per contra*, it has suffered from and been impeded by the inevitable drag of officialism and red tape, and doubtless also by dilatoriness in the government printing-office. To get out a government report with any reasonable degree of promptitude is no easy task; and to attempt it means nothing short of a single-handed fight against the whole United States government and the incurring of the resentment of every official from top to bottom whose customary routine repose has to be disturbed. But it *is* possible, as has been practically demonstrated, to issue the full production returns on or a little before July 1 of the year following that considered, and to have the manuscript of the complete report in the hands of the printers at the same time, the published volume appearing early in the autumn.

The annual report of Mr. E. O. Leech, the Director of the Mint, on "The Production of Gold and Silver in the United States" for 1892, was noticed in the June number of this Magazine. Of all the statistical tasks of the kind, that of procuring the production figures of gold and silver in this country, and of putting them together in such manner as to best meet the conditions, is perhaps the hardest. In those countries where there are official mine inspection and compulsory returns of working results it is a simple matter, amounting to a mere clerical adding up of returns. Here it is a very complex and difficult one, and of the different ways of attacking it the statistician has to choose the most satisfactory or least objectionable plan, which is usually a compromise between the hopeless canvass of the thousands of individual ore-producers, and the short cut, by means of the refineries, the coinage, and a comparison of exports, imports, and consumption in the arts. Mr. Leech, as was to be expected, has met with some adverse criticism as to method, but deserves the hearty approbation of the people for the painstaking and conscientious care he has shown in undertaking a rather thankless task.

COMMENT & CRITICISM.

A Great Work in Sculpture.

As an admirer of sculptural art, it has been a source of special gratification to me to observe the lively interest which THE ENGINEERING MAGAZINE has always manifested in our development in that direction. It has seemed to me specially appropriate that you should stimulate public interest in the subject, for it is manifest, that if American architects and engineers, together with the capitalists and men of affairs who are their patrons and associates—in short, if "the captains of industry" can be aroused to an appreciation of the sweetness and beauty that sculptural art can lend to daily life, and beyond that, the cash profit that is sure to follow an intelligent application of the art to the great structures that we are building, and to public parks and public places everywhere, we shall indeed attain unprecedented progress in that branch of art wherein America is as yet wofully deficient.

By reason of your interest in the subject, therefore, I am prompted to ask your special attention to what I regard as one of the greatest pieces of realistic sculpture that has ever yet been given to plastic art, in this or any other country. I refer to the bronze group designed to commemorate the massacre of old Fort Dearborn, on August 15, 1812, which has just been completed here by Carl Rohl-Smith, and which is now in the molds at the Henry Bonnard bronze foundry in New York. The idea of commemorating this historic event originated with Mr. George M. Pullman, and through his munificence the city of Chicago is to be presented with what has turned out to be a work of really great artistic and historic importance. Enclosed herewith I hand you a front view of the group, taken just after it was modeled in clay, and I trust that you may find place for it in your pages.

The monument will mark the scene of the tragedy, at the junction of Eighteenth street and Calumet avenue. It consists of a group of five figures, illustrating the rescue of Mrs. Helm by Black Partridge, the historic Indian chief. The representation is based upon Mrs. Helm's own version of the incident. The group is finely symmetrical in composition, the figures full of robust action, showing in the technical handling admirable strength and vigor and an intimate knowledge of anatomy. The sculptor made a conscientious and faithful study of the Indian from living models, obtained through the courtesy of Gen. Miles. His red men are therefore not Caucasians with feathers in their hair. He has grasped with remarkable readiness and insight the picturesque and plastic possibilities of the subject, and every line of these figures expresses the aborigine as distinct from the white man. The peculiar physique, movements, and attitudes of the Indian are forcibly suggested, the salient racial traits being expressed with a perfectly fearless realism, which however never merges into exaggeration.

The pedestal upon which the group will rest is to be ten feet high and measures 13'x9' 11" at the base. On this pedestal will be four bas-reliefs telling the story of the massacre, the first on the front showing the evacuation of the fort, and that on the opposite side the attack on the caravan. These are to be 7 feet by 2 feet 5 inches. The bas reliefs on the ends will depict the return of his medal by Black Partridge, and the heroic death of Captain Wells.

On the evening of August 14, 1812,- Black Partridge went to the fort, and entering Captain Heald's headquarters said: "Father, I came to deliver up to you the medal I wear. It was given me by the Americans, and I have long worn it in token of our mutual friendship, but our young men are resolved to imbrue their hands in the blood of the whites. I cannot restrain them, and I will not wear a token of peace while I am compelled to act as an enemy." This is the moment chosen for plastic representation. The scene is the interior of the fort where the men are loading the wagons, showing on the left the men and women at work; on the right the corner of the block house, the figures of Captain Wells, Captain Heald, Black Partridge, and the accompanying Indians.

Captain Wells, having fought valorously on the day of the massacre, killing seven Indians in the fight, came up to Mrs. Heald, and both were overtaken by a party of red men. His horse was shot, and he being wounded fell under the animal in such manner that he could not extricate himself. He rose to a sitting posture and called to the enemy to "shoot away." This is the stirring incident embodied in the second of the smaller bas-reliefs.

But enough has been said to indicate the striking and realistic character of the work. I conceive that its lasting value and merit will consist in the faithfulness with which the native American Indian—in feature, form, character, costume, and methods of warfare—has been preserved to us in lasting bronze. D. H.

Chicago, May, 1893.

NOTE.—A portrait of the sculptor and references to some of his other works will be found on pages 440 and 449 of this issue.—THE EDITOR.

The Advantage in Finely-Ground Cement.

REFERRING to the extract in the April ENGINEERING MAGAZINE (page 126) from Mr. Carey's paper on cement, presented to the British Institution of Civil Engineers, the statement that the residue left in a sieve with 32,257 meshes per square inch had no cohesive properties might lead some engineer or architect (not conversant with the cost of grinding) to specify for use in his work cement ground so fine that all or a very large percentage would pass through a sieve of this character.

For the benefit of any who might be inclined to ask for a cement of this fineness, I would say that Mr. Carey makes too broad an assertion when he states that a residue of this kind has no cementitious value. The extra cost of grinding to produce a cement that will pass through a sieve with 32,257 meshes per square inch would be considerable. It is a question whether 50 per cent. would cover it, and, as I will try to show further on, it is not likely that anything would be gained by the expenditure. There is no doubt that a sieve with 2500 meshes per square inch is not fine enough to use to get the best result from a cement, but very few manufacturers now use this sieve as standard, except the English.

The works with which I am connected use a sieve with 6400 meshes per square inch as a standard, and do not send out any Portland cement that has over 5 per cent. residue left on this sieve. The German manufacturers' standard is 5776 meshes per square inch. The residue remaining on a sieve with 5776 meshes per square inch, or a sieve with 6400 meshes per square inch, even if it has no setting qualities when used alone, will, in connection with the fine cement, sand and water, become disintegrated and be as useful as the fine cement. The chemical action of the water, etc., will, during the setting and induration, act on these coarser particles and make them perform their share of the work. This can be seen in the fracture of a briquette made from coarser-ground cement. The fracture will have a smooth appearance, and no signs of the coarse or sandy particles. If a cement is of the proper composition, well clinkered and ground so fine, there will not be a residue of over 5 to 8 per cent. left on a sieve with 6400 meshes per square inch, or 10 to 15 per cent. On a sieve with 10,000 meshes per square inch you will get a perfectly reliable cement, as well as the most economical one to use. Grinding cement any finer would be costly and unnecessary. Increase in cost of production naturally means an increase in the selling price. Then the question arises whether the consumer had not better pay for the residue in the cement than be compelled to pay considerably more for a cement all passing through a sieve with 32,257 meshes per square inch, or even with 20,000 meshes per square inch. Some people may say that with a very fine cement one part more sand can be used, which may be true, and that is the reason we adopted the sieve with 6400 meshes per square inch as our standard sieve, in place of the one with 2500 meshes per square inch now used in England; but the addition of sand has a limit. I question whether any competent engineer will allow a much larger proportion of sand than three to one on responsible work, while the proportion of crushed stone, etc., will be influenced by the size and quality.

A cement may be strong enough to stand six or even ten parts of sand to one part of cement, yet theoretically in any cement work all the voids are expected to be filled up, and in a mixture of six to one I am sure there is not sufficient cement to do this. This fact limits the sand dose, and without being able to increase the sand dose there will be no necessity or advantage in having the cement ground finer than it is now ground in the German or Saylors Portland mills.

The extract from Mr. Carey's paper goes on to state the tensile strength of cement with 9 per cent. residue left on a sieve with 2500 meshes per square inch and the increase in strength after the residue is taken out. This of course is true, but no engineer in the country is obliged to use a cement so coarse. Several companies manufacturing Portland cement in this country grind their cement to a degree of fineness never attained by the English manufacturers. In fact almost all the American Portland cements are being ground finer than the English cements.

There is much room for the English people to improve in grinding. At the same time, to go from one extreme to the other,—*i. e.*, from a sieve with 2500 meshes per square inch to a sieve with 32,257 meshes per square inch,—in determining whether cement should be accepted or rejected, would be a mistake. The United States and Germany are young in the manufacture of Portland cement, when compared with England, yet the manufacturers in that country have much to learn that their younger and more progressive rivals have already acquired.

Any engineer or architect can to-day get a Portland cement manufactured in this country superior to the English and on a par with the best German cement.

WILLIAM G. HARTRANFT.

Philadelphia, April 24, 1893.

A Protest From A Colombian.

MR. CHARLES P. YEATMAN'S paper entitled "Would the Pan-American Road Pay?" published in the April number of this Magazine, I read with deep interest, being myself a Colombian and interested in one of the branches of the engineering profession.

Before reading this paper several times, and examining carefully the accompanying "pictures from the countries traversed," I could scarcely have believed that such misleading statements could have been found in a publication of the high standard of THE ENGINEERING MAGAZINE, and from the pen of a civil engineer now a guest of the country misrepresented. Realizing the evil effects that some paragraphs of this paper may engender in the minds of capitalists, manufacturers, and the people at large, in foreign countries interested in Colombia, I take the liberty of presenting some remarks on this subject.

After three years spent in the United States, during which time I have met scientific men and professors, men of affairs and manufacturers, merchants, miners, and laborers, from New England to the Pacific coast, I have learned a lesson never dreamed of before my arrival in this country. It relates to the almost universal ignorance of the geography and history of Latin America, and of its social and political standing in the civilized world. Probably not more than one in a thousand citizens of North America could give on short notice more than the following information concerning Latin America, if we except, perhaps, Mexico:

1. South America is a *country* situated *down* in the tropics, and exceedingly warm, where whites cannot live.

2. It is made up of little States not independent of each other; how they are divided up for the administration of the government is not known.

3. The inhabitants are scattered in small *pueblos*, living in primitive fashion on the spontaneous products of the land. They are mostly Indians and half-breeds, the only enterprising people there being "the Americans" with their "push, ingenuity, and superior intelligence."

4. The people care only to fight and quarrel, and their main business is to kill each other as savages.

5. The natural products are coffee, sugar, and fruits, such as are used in the United States every day, and also monkeys and snakes.

6. The women have black eyes and black hair, and are pretty, and play the guitar, and sing and dance "fandangos," and are kept out of range of the men, within iron railings.

8. In conclusion, it is a great and rich country, waiting for American push and ingenuity, and a good prey for Uncle Sam when he sees it fit and ripe.

It is not my intention, however, to indulge in recriminations. Besides, this ignorance concerning my own country does not exist alone in the United States. It is even worse in Europe, except that the merchants there understand their business better, and carefully study the people of South America and their needs.

It is clear that business transactions between two countries cannot be safe without a mutual knowledge of the parties engaged. If the United States wishes to trade with South America, let it be known here what the people there really are, and what they need, and I venture to predict results far more satisfactory than those from any "reciprocity" schemes devised by politicians. Let the North Americans more generally follow the example of the far-sighted New York merchant who some time ago sent his son to a South American capital to be educated, instead of sending him to Harvard to learn dead languages.

But, coming to Mr. Yeatman's article, I feel that it would be better for us to remain as naught in the mind of the North American people than to be so grossly misrepresented as has been done in his work. I quote:

> "The reader who will study the illustrations in this paper, all of which faithfully portray types of natives in the countries to be traversed by the proposed Pan-American route, and their occupations and means of support, will be more strongly convinced than he could be by words alone of the lack of local traffic which such a railway would experience."

Again:

> "That tropical country is too sparsely settled, the people have too little need for exertion, and the governments are too unstable, to justify the risk of capital in any such venture. Reference may again be made to the pictorial arguments accompanying this paper, which can hardly fail to convince any but enthusiasts how unpromising is the field and the people for the building of an expensive railway."

It may be noticed that he gives pictures from only one of these countries,—Colombia. Under a picture of some Indians is written: "Types of the people through whose country it is proposed to construct the Pan-American railway." To a starving donkey he gives the glory of being "now considered (?) a satisfactory means of transportation by the natives." In his opinion the train of pack bullocks is the "transportation means now suited to native needs." As a faithful representation of the cities of Colombia he chooses Puerto-Berrio (!) and seems well satisfied, as well as with his type of "a neat little home in Colombia." These are not all the criticisms that might be made of the pictures, as there are several other views of a similar character.

No doubt every Colombian will feel complimented by this portrayal of his country, though I fail to see the glory in ridiculing a young nation striving to better her condition under trying circumstances,—fighting nature, contending with internal difficulties, and handicapped by foreign prejudice. The pictures referred to are correct of the people they represent, but to give them to the world through the pages of a serious magazine, as a result of nine years of experience of a professional man, as representing the country and its aspirations, cannot be otherwise than injurious.

One thing that pleased me, however, was to see Mr. Yeatman giving his fellow-citizens an account of the natural difficulties to be encountered in the building of a Pan-American road, and the probable—yes, certain—failure of any such enterprise for many years to come. That difficulties exist in railroad building in the tropics I am ready to grant to the utmost.

In conclusion, however, I may express my doubts of the "crooked isthmus of Panama and the country immediately south of it" being the "Gordian knot of the Pan-American problem." At least there is nothing in Mr. Yeatman's paper to prove it, as he only speaks of Colombia, and the projected road would cross many a country from Mexico to the "Gran Chaco," or the deserts of Alacama and the Chilian Cordilleras.

JUAN DE LA C. POSADA,
Mining Graduate, University of California.
New York, April 7, 1893.

[IT is proper to state that the paper written by Mr. Yeatman and published in the April number of this Magazine was not intended to be accompanied by the illustrations which he had also sent to this country. The use made of his material, however, was sanctioned by those in whose hands they were placed, both as to the introduction of the pictures and the addition to the text of references to them. If, therefore, any resentment should be felt by Colombians on account of what has been published, particularly if it is felt that any misrepresentation has been made, it will not be fair to hold Mr. Yeatman responsible.—THE EDITOR.]

Some Ancient Windmills.

IN the article on windmills in the February number of this Magazine the writer made the statement that the ancients have given us no indications that they were familiar with that venerable and still useful prime mover, and that it is not mentioned in "the famous work of Hero, in which the first steam-engine is described." This proves to be a mistake, and Mr. W. F. Durfee kindly calls my attention to the error in the following interesting and instructive statement:

"I have three editions of Hero's Spiritalia, viz.: Commandine's (Latin) 1575; Aleotti's (Italian) 1647; and Bennett Woodcroft's (English) 1851. In each of these editions is shown and described *a windmill blowing an organ by a plunger air-compressor*. In Commandine's edition the connection between the windmill and compressor is not at all clear in the cut. In Aleotti's the axis of the windmill has a crank on it, which is coupled to the plunger by a connecting-rod. Woodcroft shows a disk on a windmill shaft, armed with a number of pins, or tappets, which operate on one end of a lever, whose opposite end is coupled to the plunger of the air-compressor."

I have verified this statement and am surprised that I should have overlooked this singular combination of devices in a work with which I was reasonably familiar. The readers of the Woodcroft edition will find it at page 108, article 77. The windmill has four vanes, and is shaped very like the modern mill.

R. H. THURSTON.
Ithaca, N. Y., April 1, 1893.

More Facts About Immigration.

UPON reflection it will appear that the recent appearance of an article upon immigration in THE ENGINEERING MAGAZINE was not wholly incongruous. A happy way out of difficulties that seem formidable may sometimes be most readily found by some kind of engineering. The difficulties of which Colonel John B. Weber treats in the April number of this Magazine do not seem so great to all as they appear to be to him. Much depends upon the standpoint of observation. It is not uncommon to search, at a distance, for remedies, and overlook those which lie close at hand. Often the latter are even better than the former. When the late civil war closed, nearly five millions of *freedmen* were added to the population of the United States. These millions were English-speaking people, many of them familiar with our constitution, history, and laws. All of them were, in some form, acquainted with our industries, whether we speak of households, factories, farms, or mines. We were not then, and are not now, dependent upon Europe or upon any other place for an immediate supply of "privates" for our industrial army in order to develop our mines of coal and iron, "level our forests and plow our fields," to quote from Colonel Weber.

The 5,000,000 of freedmen of 1863-65 have increased to nearly twice that number, and we are under obligations to them, as our own citizens, speaking our language and introduced by us to citizenship which they had earned, partly by fidelity and partly by valor, that we are not under to foreigners who seek our shores largely as a refuge from intolerable distress or painful environment. This debt we cannot safely ignore as a nation. Nor ought it to be neglected while we are indulging the "sentiment" of making "an asylum" for distressed foreigners, which, within proper limits, we ought to continue to do. *Enlightened liberty for the world* is a better "sentiment" than "Liberty enlightening the World," in my judgment.

The trend of Colonel Weber's article is in the direction, in part, of orders and grades and classes, which are more in harmony with the aristocratic atmosphere of the kingdoms and empires in Europe than with the democracy of our republic. I hope my desire to give due prominence to the justice and equities involved in this matter will not be obscured by prejudices of race or nationality. While some nations are competing for a leading place and position on the largest continent of the world, I sincerely desire that we may perceive the conspicuous advantage that Providence has given to us by making or permitting us to be the temporary guardians—may I not say sponsors?—for so large a number of the legitimate heirs of Africa.

WM. W. CAMPBELL.

Wilmington, Del., April 17, 1893.

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THE UNIT OF VALUE IN ALL TRADE.

By Edward Atkinson.

MODERN trade and commerce consist in an exchange of services or of products for mutual gain or benefit. Very few men now consume any great part of their own product. Division of labor exists because a more abundant supply of goods can be made when each nation, each section, each State, each community, and finally each man or woman, works upon a special product to which climate, soil, conditions, and special personal skill or aptitude are most fully adapted. Each then produces more goods of one kind than each can consume. This makes *supply*. Each then wants some part of the product of many neighbors. That makes *demand*.

All men are neighbors; all States and nations are interdependent. The science of the engineer has converted distance into a mere fraction of a cent a ton per mile. The day's work of a mechanic upon the seaboard covers the cost of moving his year's supply of bread and meat a thousand miles. The western farm a thousand miles or more away is next door to the eastern workshop, and it often costs an eastern workman more to move a barrel of flour to his house from the railway station to which it has been brought than it did to get it to the station from the far-away western farm. This year eleven to twelve tons of food, fuel, fiber, or fabric will be moved 112 miles over the railways of this country for every man, woman, and child in it. The cost of this service to each one will be $10 or a little more. Each year for many years the quantity has increased greatly, and the distance but little, while the price of the service has diminished. If a pair of horses in steady work for 300 days in a year could move two tons six-

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teen miles a day, then it would take seven pairs of horses for each fifty persons to do the work of the railways at twelve tons 112 miles each. That would require the work of over 18,000,000 horses to provide the people of this country with the food, fuel, fibers, and fabrics now moved for them by the railways of the United States at a charge of $10 each, or a fraction more.

The distance is measured in miles—the price of the service is measured in dollars.

What is a dollar?

It is a coin made either of gold or of silver. A coin is a piece of silver or gold made in the shape of a flat disk and stamped by the government in order to certify its weight and quality.

The silver dollar weighs 412½ grains,—nine-tenths pure silver, one-tenth alloy.

The gold dollar weighs 25 8/10 grains,—nine-tenths pure gold, one-tenth alloy.

The grain is the common unit of weight; which dollar is the unit of value? The answer is in the law of the land.

The statutes of the United States provide that the gold dollar is the unit of value. There can be but one *unit*.

The unit of weight is the attractive force exerted between a unit of mass and some given body at a fixed distance. One cannot give so absolute a definition to a unit of value because the valuation or estimation in which men hold any given substance or product of human labor, whether gold, silver, copper, wheat, corn, or cotton, varies with the relative supply and demand.

The demand of the world for gold is constant; it will buy anything anywhere; it varies very slowly from generation to generation; the demand for silver is less in ratio to supply; the demand for copper is constant, but the supply increases in greater measure; the valuation of wheat, corn, and cotton varies with each season, in each country. The exchange of products is commerce.

Yet, without a unit or standard of value, by a comparison with which the exchange of products is expressed in terms of price, trade and commerce would be impossible except by barter.

There must be a unit of value or denominator which is the standard in all transactions. In order to comprehend the simple elements in this case one must separate the idea of money which circulates without any act of legal tender, from money of which the acceptance is forced by an act of legal tender.

The international commerce of the world consists of sales and purchases made by individuals in each country. When a sale of goods is made, the vendor buys the money. When a purchase is made, the vendee sells money. The specific kind of money in each State, country, or nation may be legal-tender paper money or promises to pay, legal-tender silver money or legal-tender gold money. But when the remittance is to be made from one country to another, each kind of money must be converted into that kind which passes current the world over without any act of legal tender.

There is but one kind of money which meets this condition, and that is money made of gold, or gold itself. It follows that, without acts of legal tender or in spite of them, without legislation or in spite of it, without international agreement, but by a process of natural selection, a given weight of gold has become the standard or unit of value in the world's commerce.

It matters not whether the gold is made into coin or not; coins are estimated or valued or may be exchanged one for another only at the ratio of pure gold in each one. Certified gold bars or ingots serve the same purpose in making international remittances and are often preferred.

The higher law of commerce, laid deep in human nature, has established gold and gold only as the unit or standard of value. This fact must be recognized in all monetary legislation in every State or nation that takes part in international commerce, and its own unit of value must be adjusted to this fact and to this condition. "It is a condition and not a theory."

The welfare and prosperity of this country depend in great measure upon the recognition of this fact and of this condition, because we produce more food than we can consume, more fibers than we can spin, more oil than we can burn, and we are tending to produce more iron than we can use. Under our favorable conditions of soil, climate, and government, our light national taxation, and our freedom from standing armies and the onerous conditions of passive war which oppress all other machine-using nations, we make these necessary products in the greatest abundance, at the lowest measure or cost of labor in terms of days or effort, and at the lowest cost per unit of product in terms of money; it follows that the working people of this country secure the highest wages, such high rates being the result of the low cost of production.

The product is greater in proportion to the number of persons employed than anywhere else; a less proportion of the product is diverted to taxation; the increase of capital is more rapid; the capital is more effective; the workmen are more free from the interference of government; finally, each workman is also free to use his own time and his own capacity without restriction except such as each one may choose to impose upon himself. In other words the working people of this country, whether engaged in mental, mechanical, or manual work, secure to their own use and enjoyment a larger portion of a larger product than those of any other country. But this product must be bought, sold, and exchanged before its benefits can be enjoyed by those who share in the work. Now, since the price or conversion into money of this our whole product, especially of our farms, depends substantially upon what the excess which we cannot consume will bring for export, all our prices must be adjusted to the world's standard or unit of value,—which is a given weight of pure gold.

Fifteen to twenty per cent. of the product of our farms is exported, varying year by year with the supply and demand.

Under these conditions it is necessary for us to maintain our present unit of value, the dollar made of gold, because all our exports are valued at the standard of gold: especially because our largest customer is Great Britain, where the standard or unit of value is the pound sterling. In 1892 our total exports were valued at a little over $1,000,000,000, of which Great Britain bought in value over $500,000,000.

The unit of value of the United States is a dollar, weighing 25$\frac{8}{10}$ grains nine-tenths fine. The quantity of pure gold in it is 23 21997 grains.

The unit of value of Great Britain is a pound sterling.

The coin which corresponds to a pound sterling, when of full weight, is named a "sovereign," weighing 123.270 grains,—eleven-twelfths fine and containing 113.0016 grains of pure gold.

The unit of value of the United States is therefore 23.21997 grains of pure gold. The unit of value of Great Britain is therefore 113.0016 grains of pure gold. The ratio of one dollar to one sovereign is 1 to 4.866. The ratio of each grain of gold in either is 1 to 1.

This valuation or estimation cannot be changed by statute, treaty, or agreement.

The effort of the advocates of a bimetallic treaty of legal tender and of the advocates of the free coinage of silver dollars of full legal tender is to alter these facts and conditions by legislation. An act of legal tender works by force. Under an act of legal tender the effort is made to force a seller of goods to accept a kind of money which may or may not contain the elements of its own value in its own substance. Gold is worth as much—that is to say, is valued as highly—after it is melted as it is in the coin. Silver dollars will not buy as much in the world's markets after they are melted as they purport to be worth in the coin. They circulate in our own country at a parity only because they can be converted into gold at their nominal and not at their true ratio.

The ratio of weight is one grain of gold in a gold dollar to sixteen grains of silver in a silver dollar, but the gold in a gold dollar will now buy nearly twice as many grains of silver in bullion as are to be found in the silver dollar.

Which shall be our permanent unit of value? There can be but one; the very name is single. It is not possible to think of two units or of duality in a unit.

Lincoln said that this country could not exist, one half slave, the other half free. The civil war justified his reasoning and his acts. The nation was established on the unit of liberty.

Neither can the money of a country exist, one half good at the unit or standard of the world's value, the other half bad. There can be but a single unit of value; it is now established, and it will be maintained. The silver craze is a rebellion against common law and common sense; this rebellion is now being suppressed.

It is manifest, however, that no nation could supply itself with a sufficient number of actual units of value or actual coins made of gold to serve in each and every bargain and sale, or to measure each exchange by an actual delivery of coin. Such conditions only exist in barbarous countries, where men cannot trust each other.

The bill of exchange, the check, the bank-note, and the government note now take the place of the actual coin; but, in order that their credit may be sustained, these titles to money or to units of value must be redeemed or paid in the units of value made of gold, or else no man can trust them.

Neither is it expedient to make use of coin or standard units of value to any great extent in actual service. The place for coin is in the reserves of banks and bankers, not often needed but always ready at the time of need. When the gold is in the bank reserve as a basis of credit, its force may be compared to the locomotive engine; when it passes from hand to hand, it only does the work of a wheelbarrow. When gold is held in reserve, it serves as a basis of manifold credits, but when in actual circulation each dollar passed from hand to hand serves for only one transaction.

These transactions consist in making exchanges of cotton for corn, food for iron, cloth for shelter, etc. The man who sells cotton buys a title to coin; he receives a bank-note, a check, or a bill of exchange, which gives him a title to coin or money held in reserve by the bank or banker.

He seldom wants the coin, almost never if he can trust the bank-note and feel sure that he may get the coin if he needs it. The coin in the bank is the unit of value or standard of redemption. It must be single, it must be just, it must be at the standard or unit of value of the world because the price which the man gets for his cotton or his corn or his iron, or whatever he sells, is fixed and determined by that standard.

Again, the man who has sold cotton, grain, or provisions and who has received a check, draft, bank-note, bill of exchange, or United States note in return for the same,—all of which are titles to dollars or other units of value at the gold standard,—may deposit such title to money in a bank.

This title to money or units of value is placed at his credit and becomes a bank deposit. It is right and just that when he spends that money,—that is, when he has occasion to draw upon the bank in order to pay for farm machinery, tools, clothing, sugar, tea, coffee, or any other article domestic or foreign that he wants,—he shall be paid in dollars or units of value of the same kind or quality that he had put into the bank,—namely, gold dollars or their equivalent.

His purchases and sales are all made in terms of dollars; a dollar is a coin; the gold dollar is the unit of value; the gold in the dollar will buy anything anywhere; the gold in it measured by weight in grains is the unit of value in the world's commerce.

The silver dollar is not a unit of value; the silver in it will not buy as much—perhaps not half as much—as the gold in the gold dollar. If the United States government did not receive it for taxes or redeem it in gold, it would be worth 50 to 70 cents, varying day by day. Can trade be safely conducted by such a standard?

If the pound, the yard, or the gallon varied day by day or month by month, could any one safely agree to buy or sell by these standards? Of course not. How then can it be safe to conduct commerce except under contracts in units of value of the same

Google

standard, and that a standard which varies only in long periods hardly perceptible in any one generation?

If these facts and conditions are admitted, then commerce consists in the exchange of product for product at a single standard or unit of value.

The unit of value of this country is the number of grains of gold in a dollar,—namely, 23.21997 grains.

The unit of value in Great Britain is the number of grains of gold in a pound sterling,—namely, 113.0016 grains.

The unit of value in Germany is the number of grains of gold in a mark,—namely, 5.53134 grains.

The unit of value of France is the number of grains of gold in a franc,—namely, 4.48035 grains, and so on throughout the world.

In all countries, whatever the lawful money or legal tender money may be, all kinds are brought to the same unit of value, the grain of pure gold in international commerce. Gold is the monetary unit of value—not by statute, treaty, or agreement, but in fact; because it is the safest, surest, and only just standard or unit that the world has yet discovered.

If the Brussels conference could bring about an international agreement to establish a certain convenient weight of gold to be converted into a new coin nearly corresponding to the $5 gold coin of this country, a great gain would ensue.

The $5 gold coin, 20 quarters, of the United States contains grains of gold	116.09985
The English sovereign, 20 shillings	113.0016
The German 20-mark piece	110.6268
The French 25 francs	112.0087
The Spanish 25 pesetas	112.006

So near are the great commercial nations of the world to a uniform standard or unit of value by weight of gold. Could it once be established, its name might well be the Token of Peace.

In commerce each man, each State, each nation serves the other, and the whole fabric rests upon mutual service. All nations are interdependent. The unit of value is established. Commerce overcomes all obstructions, natural or artificial, but the more free from obstruction the greater the mutual service. The establishment of a common coin containing the same weight of gold, known by one name—of the same value everywhere—would remove many difficulties that now obstruct trade.

If such a vision could be realized, certain great centers of trade would become the clearing-houses of the world, interchanging their certificates with each other, each keeping its own reserve of the units of value in gold coin or in gold bars, and thus often avoiding the risk and the cost of moving great quantities of gold forward and back across the ocean, creating an alarm due only to the imagination.

Prices would then vary only according to the supply of and demand for the goods, wares, and merchandise which are the subjects of commerce; and all uncertainty about the quality of the money, or about the standard or unit of value, would be ended.

Having thus assured the great central deposits of the world's money of redemption at central points available for transfer by national clearing-house certificates, the lesser deposits in proportion to our own requirements would be in the bank reserves or clearing-house centers of our own country; also subject to transfer by the issue of clearing-house certificates representative of coin or units of value.

It will be observed that the great volume of exchanges is conducted by the issue of bills of exchange or drafts, sometimes on demand, often drawn payable at a future date. These drafts or notes promising deferred payment are the representative or symbol of the products passing from the producer to the consumer. These instruments of exchange or titles to money are the subjects of discount and are dealt in by banks and bankers. It will also be observed that a very small part of the traffic of the country is conducted by the use of bank notes, government notes, or coin. Very little gold coin is ever seen in circulation; its true place is in the bank reserves as a basis of credit.

At times there is a pressure upon the reserve. When this occurs within or among the banks themselves, relief has been found in the issue of Clearing-House Certificates. What occurs is this: while some banks have large reserves of lawful money, more than they need to sustain their own daily obligations, others have ample resources falling due at a later date but not at once available. Then the banks combine; each bank needing aid to meet its daily obligations places in the hands of a committee its securities of undoubted character available or payable at a future date; upon these securities the clearing-house certificates are issued at the ratio of seventy-five per cent. of the value of the securities pledged by each bank under the guarantee of all the combined banks in the association. [For forms see page 698.]

These certificates pass as money in the settlement of bank balances; they are held to the standard of redemption in lawful money; the gold itself is not wanted in any of these transactions; what is required is an instrument of credit tied to the standard of redemption in gold and backed by the reserves of all the banks combined in that association.

If the draft on reserves becomes general and a semi-panic ensues, the emergency is met by the combined banks each supporting the other. If it goes so far as to reduce or imperil the joint reserve, then the credit extended by the banks to the community is cut down, trade suffers, buyers and sellers are kept apart merely because the mechanism of exchange is disordered, as it is now. At the present time the country is full of the elements of wealth and welfare; real capital is abundant; labor has been fully employed at the highest rates of wages. The world needs all that we have to spare. Only the mechanism of exchange is disturbed by distrust.

May there not be found in this invention of clearing-house certificates a solution of the problem of the currency? A certain amount or quantity of small notes, bank bills, and the like is required, but this quantity varies at different times and seasons. The coin or lawful money cannot be drawn from bank reserves without restricting the basis of credit at the time when credit is most needed. What is needed are instruments of credit in small sums that may pass from hand to hand as the transactions become greater or less. Gold is not needed and is not as suitable as a note, but the redemption of the note must be absolutely assured. The national bank notes are secured by the deposit of United States bonds. The tax on State bank-notes is maintained, not for the purpose of collecting a revenue, but for the purpose of preventing the issue of such notes. A fear exists lest the redemption or payment of the note on demand may not be assured. Bad banking imperils the note as well as the deposit.

There are many other securities which would be as safe in support of bank notes as the bonds of the nation. How and by whom are they to be selected and held?

It should be observed that the losses by bad debts on the wholesale traffic of this country in any decade are less than one-half of one per cent. a year. No well-managed bank would pay the strongest guaranty company one per cent. upon the obligations discounted by it to assure payment at maturity. At all times and under all conditions the obligations held by well-managed banks are sure to be ultimately paid to the amount of over 99 per cent.

of the total obligation. It is an evidence of bad banking if they are not, and bad banking is sure to be detected by the managers of a clearing-house.

It is from the best of these obligations at 75 per cent. of their value that the securities are selected by clearing-house committees when clearing-house certificates are issued upon their pledge. They are representative of property of the safest kind or of products of various kinds on the way from producer to consumer, valued at the world's unit of value,—gold coin.

It needs but one step more in the development of this invention and we should be served with the safest type of currency,—clearing-house certificates bearing no interest to be issued in sums of $5 and $10 to the order of each bank that could use them for general circulation, redeemable on demand by such bank, or in default redeemable in coin at the clearing-house, which would reimburse itself from the securities deposited with it.

An annual charge of one per cent. per annum by the clearing-house would more than compensate for losses and expenses.

If it is necessary or expedient to maintain national supervision, it may be justified because these certificates would circulate as money. That supervision would not be diffused as it now is over more than three thousand banks, but would be limited to the several clearing-house associations, where the strictest care could be maintained over the quality of the securities pledged by each bank for the redemption on demand of the certificates issued to it. A very small tax payable to the government would suffice for the payment of the most competent supervisors.

No one could be forced to take these instruments of exchange, they would not be a legal tender; but who would refuse them?

The ebb and flow of these certificates would correspond to and would be the representative of the volume of traffic. When money is called for to move the crops, these certificates would serve as the medium; they would be symbols of the crops, and the consumption of the crops would furnish the means of redemption. Behind them would be the central reserves of gold coin, next the securities representing property or produce at gold value, next the capital of each bank to which they were issued, finally the combined capital of all the banks in the clearing-house association from which each class of certificates emanated.

If such a currency would not be safe, no currency except one based dollar for dollar upon gold coin would be safe.

Commercial paper well chosen, representative of products on the way from producer to consumer, is a safer basis of security for small notes than the bonds or evidences of debt of nation, State, city, or town; because such obligations are representative of the active capital of the whole community of which the use or consumption will furnish the means of redemption.

When the standard or unit of value is assured and redemption is certain in gold or its equivalent, the gold itself may rest in ample reserves to be drawn upon only in settlement of balances.

If the credit of the unit of value is endangered by the threat of forcing the people under acts of legal tender to accept coin made of silver which is worth less as bullion than it purports to be worth in the coin, no device for supplying notes or any other form of currency will suffice, and no safe system of banks or banking can be maintained.

Credit will be refused to the individual citizens of a country which supports such measures, because by their very support of them they declare themselves not fit to be trusted.

There is a unit of value. It exists without regard to legislation, treaty, or agreement. It is gold. To that standard of value the monetary system of every commercial State must be adjusted. A given weight of gold is the standard of value everywhere; with it all products can be purchased and all debts can be discharged. No other substance or product of human effort meets these necessary conditions.

Although a given weight of gold is *de facto* the unit of value of the commercial world, it by no means follows that silver will cease to be used for subsidiary purposes. Bi-metallism exists *de facto.* Tri-metallism exists. Quadru-metallism exists. Gold, silver, nickel, and copper are made use of for conversion into coin, and these coins are used for monetary purposes.

What is in fact proposed under the technical name of "bi-metallism" is to undertake to maintain silver coins of given weight at a parity or equal to gold coins of given weight under a system of bi-legal-tenderism; an awkward combination of words, but one which is necessary to express the true purpose.

The origin of acts of legal tender among English-speaking people was the decree of an English king making it a penal offence to refuse the king's money after he had debased the coin of the realm.

No act of legal tender is required to enforce the acceptance of good money. The only true definition of good money is "a coin which is worth as much after it is melted as it purports to be worth in the coin."

A gold dollar or its multiple in coin meets this condition; it is good money. A silver dollar does not meet this condition; it is bad money.

Under this pretext of free coinage the attempt is made to force bad money into circulation by an act of legal tender.

What is sought is a treaty under which either gold coin or silver coin at certain proportionate weights may be forced upon creditors by debtors under acts of international legal tender. The prospect of such an agreement is very remote. Without it silver will continue to be used for monetary purposes in the form of coin, perhaps by many poor nations as almost the only coin or medium of exchange; by others for subsidiary purposes. Under these conditions gold will maintain its position as the unit of value in the world's commerce, and only those nations will hold a position either paramount or equal in their terms of competition with others that maintain the gold unit of value both for their external and their internal trade and commerce.

It is told in one of the old nursery tales that the pig on the way to market would not get over the stile, the dog would not bite the pig, the stick would not beat the dog, the fire would not burn the stick, and so on; the whole procession was stopped by the pig. The pig that won't move now is pig silver piled in the Treasury vaults. Move it out of the way. The law is plain. If the act compelling the Secretary to buy pig silver is construed strictly in all its parts, it is as much his duty to sell pig silver as it is to buy it. He must sell the excess when the amount in the Treasury exceeds the amount of notes outstanding which were issued for its purchase. The law provides that "no greater or less amount of such notes shall be outstanding at any time than the cost of the silver bullion *then* held in the Treasury purchased by such notes."

Of late the people have refused to keep the notes outstanding, —they are being presented for redemption faster than they are issued. The amount of pig silver at cost now in the Treasury is greater than the amount of the notes outstanding. That condition is contrary to law. What other course is open to the Secretary of the Treasury than to move this pig silver to market by selling the excess so as to keep the amount of bullion in the Treasury at cost "no more and no less than the amount of notes outstanding?"

THE LEADVILLE OF TO-DAY.

By A. F. Wuensch.

LEADVILLE, with its great bonanza mines, and its phenomenal record of a metal production in fifteen years of nearly two hundred million dollars, presents an ever interesting and fascinating subject. The story of one of nature's most prodigal gifts of mineral wealth, of rapid and great industrial achievements, and the commercial and social results accompanying the development of a great mining camp, can never become stale or tiresome. Leadville is near the center of Colorado, and, since the development of its mineral wealth, it has been practically the heart and life of the State. The opening of the district in 1878 gave a new impetus to mining in the Rocky mountains generally, and the initial product of Leadville mines built the first fine business blocks of Denver and other western towns, and supplied funds for the first miles of railway of some of the most important lines of the present day in the west.

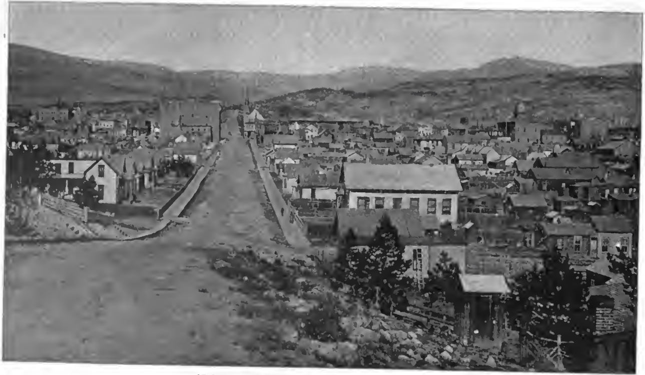
Owing to its high location—10,200 feet above sea-level—the place is frequently referred to as the "City of the Clouds." It is two miles above coast cities, where the clouds are supposed to hold supreme sway; still there is hardly a place on earth that can boast of clearer and brighter skies, or a quieter and more agreeable atmosphere. To be set down unexpectedly in Leadville, one would not appreciate the altitude unless he were an experienced mountaineer who, perceiving the absence of forests on the mountain sides a few thousand feet above the plane of the town, would readily estimate the elevation.

Leadville is situated on the eastern edge of a valley three to seven miles wide and twenty-five miles long. To the westward, ten miles distant, is the continental divide, composed of Homestake, Massive, Elbert, and Harvard peaks, some of which are over 14,000 feet in height. The foot hills or skirts of this range slope down until within five miles of the western portion of the city. Between Leadville and the range is the undulating valley, four or five miles wide, through which flows the Arkansas river,—at this point a mere rivulet, for its source is at the head of the valley but ten miles distant. The mountains, where they lift their rugged crests above "timber line," present somber corrugated masses of archæan granite, and in all probability this range has not been submerged by the sea since the original upheaval.

East of Leadville is a parallel range of mountains, nearly as high and prominent as the one on the west, but far more interesting to the miner. Its crests are composed of sedimentary rocks, limestones, shales, and quartzites,—in part the detritus derived from the great granite mountains, and deposited in the sea when the larger portion of this western country was under water. It is in the blue carboniferous limestone of this range, and its foothills sloping down to the town of Leadville, that the great ore deposits of the district are found.

Just to the south of the town is a narrow gulch, running east and west, which has its source in the east range, and, cutting through the most productive portion of the mineral-bearing area, debouches into the Arkansas river valley. This is California gulch, where, in the early "sixties," five or six millions of dollars were taken out in placer-mining, by the most primitive methods of gold-washing,—the pan, rocker, and ground sluice. Along the lower portion of the gulch are the great silver-lead smelters of the district. Leadville, like many other great lode-mining camps, has been established on the site of former rich placer-mining territory.

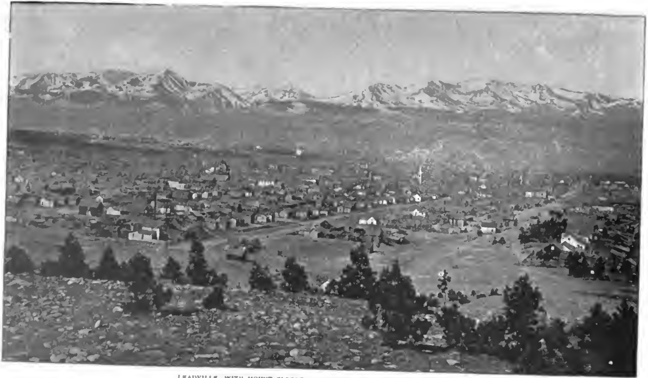
It was for the purpose of working over some of the low grade auriferous gravel of the gulch that Messrs. Stevens and Wood went to the district in 1874, and discovered and appreciated the value of the masses of carbonate of lead ore, which they proceeded to locate and develop. It was not until the beginning of 1878, however, that any very important discoveries were made, and the district began to attract general attention. In the spring of that year several sales were made at large figures, and the erection of the Harrison Reduction works—the first smelter—was begun. From that time the development of the camp was so rapid, the discoveries so startling, and the business transactions of such magnitude, that even the broadest and most sanguine minds were dazzled, and, failing to grasp the real magnitude of the district, and the vastness of the wealth within reach, rushed to extreme measures. There was no time for sober second thought. Judgment and reason were supplanted by a belief in luck and the advantage of prompt action. The early and many accidental successes led to a somewhat indiscriminate development of the district, sections most



LEADVILLE, COLORADO—VIEW OF THE CITY FROM CAPITOL HILL.

SCENE IN EAST SIXTH STREET, LEADVILLE.

unfavorably situated receiving the same attention as those subsequently shown to contain the best mines. In a comparatively short time a thousand shafts and prospect holes had been sunk on the hills to the east of the city, and then opportunities were afforded for studying the geological structure of the country and the character of its ore deposits. Only then it was discovered and fully demonstrated that the ore bodies rested in great channels or troughs on or in a certain zone, ascertained to be the blue limestone, in the sub carboniferous formation; also that nature had systematically placed this zone in a position most favorable for the economical extraction of the ore. At intervals of one-eighth to one-half mile the formation was broken through by great meridional fractures, and by compression lifted up or faulted, so that the same ore plane came repeatedly to the surface, very much like the steps of a stairway which had been covered with débris, and brushed down on a regular slope, leaving the outer edges of the flat parts of the step exposed. This condition further helped to distribute the wealth of the district among its many energetic adventurers, as each succeeding rise shut out the discoverer of the vein below when he reached the faulting or uplifting line. It also gave rise unfortunately to much litigation as to titles. Another feature that prevented the district from falling into the hands of a few large corporations, and the retarding of its immediate and rapid development, was the frequent absence of any other covering over



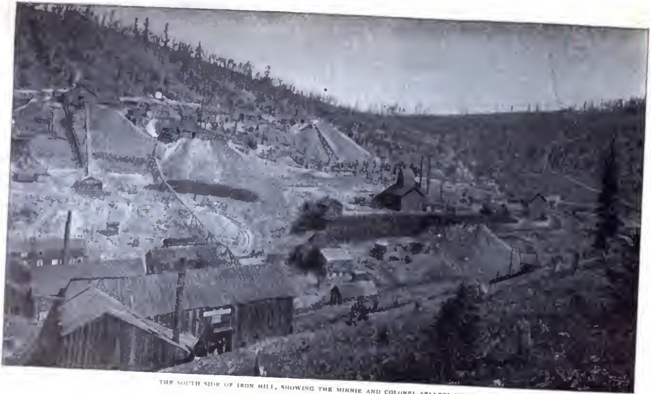
LEADVILLE, WITH MOUNT ELBERT AND MOUNT MORRISON IN THE DISTANCE.

the rich ore bodies than a few feet of detritus, effectually preventing the establishment of an "apex" and vein in place that could be followed, as the United States laws provide, indefinitely in its course into the earth.

In the spring of 1880 occurred the great strike for reduced hours and increased wages, which reacted most unfavorably for the working classes of the district, as the strike failed, and the occasion was used as a good excuse for suspending work permanently on hundreds of prospecting shafts of no demonstrated value, and of which their promoters were heartily tired. The production was not greatly retarded, however; ore was taken out at a wonderful rate, and four or five millions of dollars were paid in dividends during the year. Up to and including the year 1882, it is doubtful if any ore was raised from a depth of over three hundred feet, and all ores extracted were carbonated or oxidized, in other words, altered by surface water and atmospheric influences, putting them into the best possible condition for smelting as practiced at Leadville at that time.

Beginning with 1885 the conditions began to change, gradually at first, and more rapidly after a time. Greater depth became necessary and the ores became lower in grade and more refractory as the oxidized ores became exhausted and the deeper sulphide deposits were drawn upon. In addition large flows of water were met with. These changes called into play all the ability and re-

LAKE COUNTY COURTHOUSE, AT LEADVILLE.

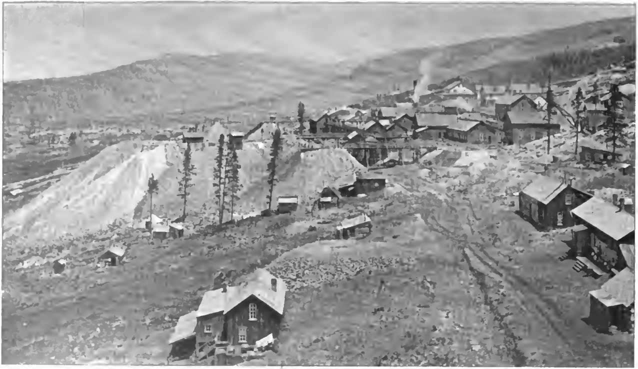


THE SOUTH SIDE OF IRON HILL, SHOWING THE MINNIE AND COLONEL SELLERS MINES.

MAID OF ERIN MINE, WASTE DUMP, AND ORE-HOUSE.

sources of the mining engineer and metallurgist. The speculative element declined, and scientific and practical work was demanded, with large capital to assure success. The era of permanency and stability was ushered in. Enterprises calling for the expenditure of hundreds of thousands of dollars before return could be expected became common, and the result to-day is that Leadville has kept up a production of the approximate value of a million dollars per month, and is on a sound footing and assured of a continuance of an equal production for the next twenty-five years. This steadiness of output rests not so much upon the continuance of bonanza mining in a few individual mines as upon the opening of new ore-bearing territory, by which the high general average of the district as a whole is maintained. The producing area of Leadville has gradually been extended until the blue limestone has been proved profitably mineralized from Evans gulch on the north to Empire gulch on the south—a distance of four miles—and from the eastern half of the city eastward towards the East or Park range for an equal or greater distance. The area is more or less irregular, but embraces about fifteen square miles, and, as an average mining claim covers less than ten acres, if regularly laid out, there would be room for at least a thousand full locations within the recognized ore-bearing territory.

The district is segregated by gulches and elevations resulting in many subdivisions, the majority of which are probably well known

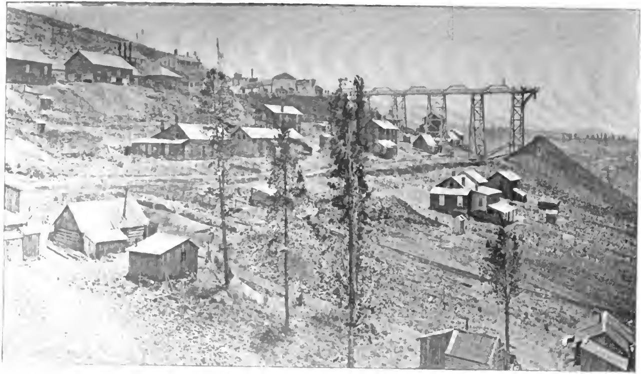


THE IRON SILVER MINE, WEST SLOPE OF IRON HILL.

to many readers by even their local names. Carbonate hill is just east of the city, some of the streets extending well up the slope of the hill where the miners' cottages are intermingled with the shaft-, engine-, and ore-houses of some of the lower mines. North of Carbonate hill is Fryer hill, and east of the latter is Yankee hill, and then Little Ellen hill. Carbonate hill rises to a height of 600 feet above the main street of the town, in a gentle slope. East of Carbonate hill is Iron hill, reaching an altitude of 11,000 feet. Still further easterly, rising up in irregular terraces, Breece hill, Bald mountain, and the range peaks are successively encountered. South of the above described belt are Rock hill, Long & Derry hill, and other local sections, all possessing good mines.

Fryer hill, the most thoroughly worked portion of the Leadville district, and now practically exhausted, is a low rolling hill about 2000 feet in its greatest length and 1500 feet wide. On this little area are located the Chrysolite, Little Pittsburgh, Little Chief, Amie, Climax, Dunkin, Matchless, Hibernia, and Robert E. Lee mines. More than $30,000,000 worth of ore has been extracted from these mines, and dividends of about $12,000,000 paid. No ore was mined at a depth of over 250 feet, the bulk having been taken out at 75 to 150 feet from grass-roots. The surface of the hill now presents the appearance of having been visited by a destructive earthquake. The timbers of the old mines have given way almost everywhere, and the whole surface is broken and sunken

THE NEW PENROSE MINE, LEADVILLE.

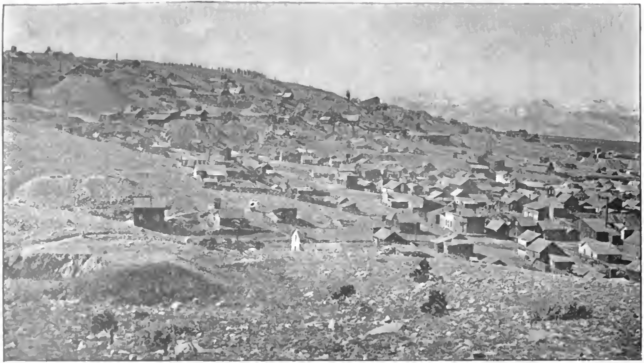


SILVER CORD MINE ON THE WEST SLOPE OF IRON HILL.

STACK OF BASE, OR SILVER-LEAD BULLION.

and fissured by wide crevices until it is no longer safe to set foot on the greater portion of it.

While Fryer hill is no longer a factor in Leadville's ore production, other parts of the district are still yielding as largely as ever, while a number of localities that were unproductive a few years ago are now producing liberally. Carbonate hill furnishes about as much ore as ever, although the output is largely made by some of the more recently opened mines, while some of the large producers of 1880 have ceased their output altogether. The largest producer on the hill is the Maid of Erin Consolidation, which produces from 5000 to 7000 tons of ore per month, and whose annual yield aggregates over $2,000,000. About half way down the slope of Carbonate hill is one of the faults or displacements of the ore zone, already referred to, where the ore plane is depressed 500 or 600 feet. From this line the ore plane is expected to extend nearly horizontally westward under the town, concealing, beneath the vast superincumbent mass of earth and porphyry, millions of dollars' worth of ore. Three shafts, all within the confines of the city, have lately penetrated to this ore plane, and all have disclosed heavy bodies of rich ore. A number of bore-holes have also been put down to prospect the area. The extent of the ore has not been determined, although a vigorous campaign has been in progress for over two years. The principal obstacle has been the great flow of water encountered. One shaft alone, the Penrose,



LEADVILLE, COLORADO—WESTERN SLOPE OF CARBONATE HILL.

is now pumping 2,500,000 gallons of water per day. The expense is very heavy, but the promise of returns fully warrants even greater outlays. As near as can now be determined, the area west of the fault and extending under the city will yield as much ore as has been obtained up to the present time from the Carbonate hill mines, an amount estimated at $28,000,000. And as Carbonate hill mines were more accessible, and have been worked for fifteen years without exhaustion, the area under the city should be good for twenty five to thirty years' work when once opened up. The other two shafts that are struggling against water, and for a wealth of chloride of silver and lead carbonate ores, are the Bohn shaft and the Sixth street shaft. The latter has already cost its projector, it is estimated, more than $400,000, with no output except a flow of water from its pump as large as a good sized trout stream. The reward, however, is near at hand.

A development of more than usual importance to Leadville is the large body of ore disclosed some months ago in the Little Johnnie mine, on Breece hill. This region is comparatively undeveloped, is very extensive, and gives promise upon further exploration of disclosing many more bonanzas. The Little Johnnie mine has lately begun shipping 2500 to 3000 tons of ore a month. The ore contains a little copper, some lead, runs fair in silver, and contains from $10 to $30 per ton in gold.

The development of the Leadville district, like the growth of a city, has been from a central point, and is rapidly extending in all directions, and no apprehension need be felt that the limits of the district will soon be reached. In addition there still remain large areas in the heart of the producing part of the region that are still unexplored. In fact the amount of ground actually thoroughly opened up or worked out would probably not aggregate one square mile. However, this is an extensive area when the labor involved in breaking and surfacing ores and timbering the workings is considered. Entering one of the larger mines on Carbonate or Iron hill, one can walk half a day and not traverse all the underground workings, as in many sections where the ore is strong drifts are driven at every fifty feet, and the whole mass is blocked out. Frequently also the ore is twenty to eighty feet in thickness, and more, and levels are driven one above the other. The average annual output of the mines now is almost 400,000 tons, gross weight (including moisture). Since the opening of the Leadville mines probably 4,500,000 tons of ore have been mined and smelted.

LEADVILLE, COLORADO—AMERICAN AND ARKANSAS VALLEY SMELTERS.

The large tonnage of the mines, and the great demand of the town and mines for supplies and fuel, early stimulated railroad building, and in the fall of 1880 the Denver and Rio Grande railway reached Leadville. It was followed some time afterwards by the South Park branch of the Union Pacific, and more recently by the Colorado Midland. From 120,000 to 190,000 tons of ore and 30,000 to 50,000 tons of base bullion are hauled annually over these lines, the former paying $4.80 per ton to Denver, and the latter $8 per ton. Leadville is behind many camps of much less magnitude in the matter of local transportation from the mines. All ores are still hauled by team from the mines to the smelters or railway sidings. About 150 teams, all of the heaviest stock to be obtained, are employed. From two to four trips a day are made, according to length of haul, and the loads range from 9000 to 13,000 pounds net. Two of the railways entering Leadville began about ten years ago to build spurs to the leading mines, did considerable grading, and laid some rails, but merchants and others protested vigorously in behalf of the teamster, and railway building was abandoned.

As a result of fifteen years' work, Leadville shows a gross yield, figured upon the actual commercial value of its output, of $183,000,000. Out of this product about 1,600,000 tons was exported to smelters outside of the district, for reduction. The product from the remainder, after smelting, was shipped to Eastern refining-works as base bullion,—*i. e.*, pig-lead bars, containing silver and gold. About 400,000 tons of lead in this form has been shipped from Leadville, which contained approximately 75,000,000 ounces of silver, or over 2500 tons, and about 200,000 ounces of gold, or nearly seven tons of pure gold.

At present the Leadville district has about eighty producing mines, besides about one-third as many prospect properties. On these mines, not a few of which have several working shafts, there are about 300 steam hoisting-engines, from the small surface hoist on shallow shafts to ponderous affairs lifting large loads a thousand feet. Boilers aggregating 15,000 to 20,000 horse-power are in use. Coal and petroleum residuum, the latter obtained from the oil-fields of Florence, Colorado, are used as fuel. About 2400 men are employed underground, their wages being $3 per day, and the men average 275 days per year. About 600 men are employed on the surface. The annual pay-roll to surface and underground men at mines amounts to $2,500,000, and the other expenses of the mines to $1,000,000 more, of which about one-half is for imported supplies, such as candles, powder, steel, tools, and machinery. An

GOVERNMENT FISH-HATCHERY, BASE OF MOUNT MASSIVE.

estimate of the value of the mining property at Leadville is not easily arrived at. By the eleventh census, the value of mining property in the district was placed at only $27,348,000, of which over $6,000,000 was reported to be in underground developments, about $1,000,000 being in machinery. Under the State law mines are taxed, their valuation being determined by the previous year's production, one-fifth of the gross output of a mine usually being accepted as the proper assessed valuation to be placed on the property.

The smelting industry as now developed at Leadville is equal to that of any other mining district in the world. There are six large and well-equipped reduction-works, having twenty five upright water-jacket furnaces, with an aggregate daily capacity of about a thousand tons of ore. These establishments give employment to some twelve hundred men. In the early days, when the ores were richer in lead than now, and oxidized, the work of reducing the product of the mines was a comparatively easy matter, for then the ore, to use a phrase common at the time, "ran through the furnaces like butter." With the opening of the deep and wet mines, and the change of ore to sulphides, smelting has become a more expensive and slower operation. Great numbers of large preparatory calcining furnaces are now required, in which the ore is first partly desulphurized and thus prepared for final treatment. The water-jacket furnaces are all of the largest patterns in use, being frequently 120 to 140 inches in horizontal length at the tuyeres, and as wide as it is practicable to make them and still allow the blast to penetrate the center of the charge. During the past year a new method of smelting was introduced by the Bimetallic works, whose product is an iron and copper matte, which takes up the silver and gold, and which is subsequently shipped to eastern works for refining. In the furnaces of this establishment heated air is used, which, in conjunction with the sulphur in the ore, supplies the heat necessary to bring about the matting of the ore.

The city of Leadville has a population of about 12,000, and several thousand people more reside on the neighboring hills and gulches. The older residents have begun to like their elevated homes, and are profuse in their praise of the healthfulness of the climate. There is one principal business street in the city, with many good, substantial brick and stone business buildings. The residences are all wooden structures, but many of them are large and tasteful. There are three large brick school buildings, and the streets of Leadville in the morning and evening are as full of children as any Mormon settlement,—all of them healthy and with voices and lungs that can make themselves heard on hills a mile away. It is hardly necessary to say that there are good banks, live newspapers, electric and gas plants, waterworks, and other modern improvements of the best kind, in this wonderful mountain city.

The average citizen of Leadville is well-to-do. Many are interested in her smelting and mining enterprises, and have been successful. There is another class, in comfortable circumstances, but which makes no display of its means. It is composed of the successful leasers or tribute workers who have followed the operations of the large mining companies, and have taken in the aggregate vast sums of money from seemingly worked-out mines, on which they paid a small percentage. To this class also belongs the successful and energetic contractor. Many of these people are worth from $10,000 to $100,000, but their accumulations are known only to themselves and the banks in which they keep their money.

ELECTRICITY IN THE HOME AND OFFICE.

By Frederic A. C. Perrine, D. Sc.

A WRITER in one of our scientific journals a few years ago, in commenting upon the proposed utilization of the water-power at Niagara Falls, stated that, when the generation of electricity had been cheapened by the use of such great reservoirs of energy, we might hope to see it aiding us in many of the annoying and wearying details of daily life. The housewife would be able to run her sewing-machine without fatigue, our homes would be heated by means of the electric current, the business man would sit in his office ventilated by an electric fan and go back and forth between his home and business on a genuine rapid-transit electric road.

Had such a paragraph been shown to a busy electrician at the time he would have classed it among the many guesses at what "might be"; a "prophesy" if you choose, but hardly worthy of his serious attention.

"Yes," he would have said, "all this is perfectly possible, but you and I will hardly see it; electricity, however produced, costs too much." And perhaps he would have cited to you the famous "electrical-heater" man of the Philadelphia exhibition in 1884 who, by some hook or crook, obtained a space in the Franklin Institute exhibition of that year, but who figured in it most largely as the butt of all the practical jokers among that very lively set of exhibitors.

It was easy enough in 1884 to figure out the losses all along the line from the coal-pile or the waterfall to the heat developed, and prove that this fellow was a fool; but the existence at the present day of several large companies making and selling such apparatus is sufficient proof that he was not, even then, dreaming of impossibilities.

While the eyes of the majority have been turned towards the great central-station lighting plants, networks of electric railroads, or legal battles over the ownership of fundamental ideas, a constant progress has been made in the problem of the domestic utilization of the varied powers of the electric current and its fellow, the oft-neglected magnet.

To-day it is not merely possible to rival the wonders of the

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home of Monte Cristo in an every-day office building, or in the fittings of a modern residence where an electric current is available, but a contractor will not be so much as surprised at the elaborate demands you make upon him. He will sit down with his catalogues and, allowing you to choose the particular style of fittings required, will give you an estimate, and to-morrow be ready to put his men at work upon your dwelling putting in place many conveniences you now hardly dream of.

But other such residences have already been completed, and we will see many interesting and ingenious devices for the conveniences of a family should we accept the hospitality of a host who is fortunate enough to have kept himself acquainted with the progress of electrical appliances and to be possessed of a dwelling where the electric current is readily available. Perhaps he prefers burning his coal under the boiler of an engine located in his barn to consuming it in the numerous fires necessary for cooking, heating, and lighting in a country mansion, or it may be that the mains of a central station run near his city house. At any rate he has the necessary current available.

Let us suppose that we have met on a rainy winter evening and have accepted the invitation of this genial host to dine and spend a night under his roof. He knows that we have never before seen a house appointed as his, and perhaps with a touch of pardonable pride he calls into action all the appliances at his command. As we ascend the steps to his front door he pushes aside the escutcheon about the push-button of his door-bell and there are revealed two other buttons, one white, the other black. The white one is pushed, and at once the vestibule door flies hospitably open and at the same instant a flood of light is thrown upon us from an electric lamp placed overhead, which enables our host to find his latch-key and let us into the hall without any annoyance of waiting outside in the rain. As we are removing our coats the host touches a button in the hall which extinguishes the vestibule light and explains that, had he pressed the button disclosed through the escutcheon as a visitor might, he would not only have thrown open the door and lighted the lamp, but would also have summoned a servant to open the inner door and receive our card; but that the two concealed buttons were for the use of the master of the house, so that he could light his way on entering and extinguish the light on leaving his house.

It is a comfort which those who have never enjoyed it are unable to appreciate, to live in a house which is completely lighted by electricity and in which the switches are conveniently placed. There is no annoyance in searching for matches in the darkness of an unfamiliar room ; no constant danger as we light our match to ignite the gas of burning one's fingers or of setting fire to the adjacent draperies. But as we enter each room one or all of the lights may be turned on from the outside. There is no convenience in burning any light longer than it is needed, for with the same ease that a gas-jet may be turned up or down an electric lamp may be completely extinguished or brilliantly lighted again. The housewife may delight her friends and family by her dainty conceits of decoration about her lamps and chandeliers with no fear of fires from a breath blowing some light drapery into a neighboring flame. And after spending the evening with his reading lamp in exactly the position to suit his eyesight or whim, the master may retire, and by turning a switch at his bedside cut off all current from entering the building.

But our host, who has just ushered us into his library where his wife sits with the children before a blazing wood-fire, is possessed of many luxuries besides this great one of complete lighting. There is yet time in the afternoon for a cup of tea before dinner is announced, and the maid soon enters with the tray, which she places before her mistress and, after adjusting the plug attached to a flexible cord leading from the water kettle into a socket in the wall near by, departs. Then our hostess, having turned on the current by a switch at her hand, asks each his preference as to cream and sugar, and by the time the cups are arranged ready for the tea-making the water is boiling furiously, and soon we sit down for our chat, each holding a steaming cup of tea made from water which has never been approached by fire. As the talk proceeds, touching now upon the rare books, china, and silver on the library shelves, the thought occurs to me that extraordinary precautions are needed here to protect against burglars, and, on inquiring concerning this, we find that here also electricity has aided in making comforts for the head which wear the crown of magnificent possession.

Should a door or window or shutter of the house be opened or a leaf or drawer of a cabinet be tampered with in the night, at once the room intruded upon becomes brilliantly illuminated by a lamp which is set in the ceiling and out of reach to smash ; in the master's room a light springs up at the ringing of the alarm bell, and the news of the intrusion is at once telegraphed to the nearest police station. Should the burglar attempt to escape through the house, he must light room after room as he opens the doors.

Against a fire, too, these elaborate fittings have provided whatever protection man has devised against that all-destroying fiend, and it is at least possible to aid the exit of the unfortunate inmates of a burning house. In each room are several of what are called "thermostatic push-buttons,"—little devices which close and keep closed an electric circuit whenever the temperature of the apparatus rises above a certain amount. When this occurs in any room, at once every room in the house is lighted, bells ring loudly in all the bed-rooms, and at the same time the nearest fire-alarm box is automatically pulled and the alarm sent in. Help is brought at once, but, above all, those who are escaping from the burning building are not still further imperiled by confusion in the darkness.

But as the narration of these wonderful appliances has been completed dinner is announced, and we are ushered out to a meal cooked, and well cooked, but not by coals on fire. There are no burned spots on the meat, nothing scorched and nothing underdone, but the cooking is rather of the order of perfection of a dinner prepared in the old, evenly heated brick ovens. The electrical baking-oven, in which this meat has been so perfectly prepared, is heated entirely from the inside, and by asbestos packing and burnished external surfaces all radiation to the outside air is checked, so that the heat generated is entirely used in the operation of cooking.

External vessels seated on the top of the stove are not generally used in cooking by electricity, but each sauce-pan, kettle, frying-pan, griddle, or broiler is provided with its own electrical heater, and only while cooking is being done is any current used in a particular utensil. On the table itself the chafing-dish is provided with an electrical heating device, and to-night our host turns the current on the coaster for a few minutes to warm the claret which has yet the cellar chill upon it. We find, as we talk of these things, that even the fair daughters bless the advent of electricity at their dressing-table, for by its aid they are relieved from the smoke of gas or the annoyance of an alcohol lamp in heating their curling irons, while they are never annoyed by a light which cannot be moved and made to shine in some one fold of the gown.

While we have thus been chatting of these appliances, dinner has been completed, the evening far spent, and we make ready for retiring with the final instruction from our host that we should set the thermostat over our beds at the temperature at which we desire to sleep, and the electrical heater just under the window will warm the incoming air and give us a constant temperature to foster pleasant dreams. We need have no fear of fire or waste of current, for the thermostat will shut off the current as often during the night as the temperature rises above that which we desire.

The successful introduction of the various electrical cooking and heating devices has been dependent upon the invention of apparatus for transforming electrical energy into heat which should be at the same time efficient, convenient to use, and durable. When the "electrical-heater" man of 1884 was made the subject of ridicule and the butt of the practical jokers, it was mainly because his apparatus as it existed did not and could not solve the problem. He had packed a lot of German silver wire in powdered lime and was vainly fancying to himself that he was possessed of a practical piece of apparatus. But his wire was large and long, and the protection that he gave it did not prevent its being gradually oxidized and finally destroyed. So that, while he may have contributed to the knowledge of the necessities in electrical heating, it was not a practical commercial possibility till the idea of excluding the air from the hot wire by an enamel baked on it or a coating of cement became developed.

To review the various operations requiring heat and to devise apparatus in which we can use the electrical heater in performing these operations is simply a matter of design, but to day we can say that cooking by electricity is a practically possible thing, which it was not by any means before the invention of a successful electrical heater.

Just here, however, the important question arises of the economy and cost of this radical departure from the ordinary method of procedure in these well established operations of the household. That there is a real economy of energy I do not believe any one would be able to doubt if the electricity be generated in a station where the engines are not consuming over three pounds of coal to the horse-power. For estimating all the losses in the dynamo at about 15 per cent., in the mains at 5 per cent., and in the heating apparatus at not more than 10 per cent., we have a total efficiency of about 70 per cent. of the power of the engine transformed into heat and used in the cooking by the electrical heater, or, taking into account the efficiency of the engine, approximately 11,000 foot

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pounds for three pounds of coal, which is an efficiency of about twenty-five per cent. But even this great loss is much less than can possibly be obtained by firing the coal under a cooking-stove, where the best results ever obtained do not give an efficiency of more than 6 per cent. Still we must not forget that the coal which costs us $5 or $6 a ton when delivered into our cellar ready to be consumed in the cooking-stove cannot be delivered to us at any like cost when its potential energy has been transformed by a boiler, engine, and dynamo into electrical energy and delivered at our cooking table over the mains of the electrical-supply company. We must pay for our conveniences in interest on the great plant necessary for their conversion as well as in salaries of all those employed, as also we must reward the capitalists investing in the apparatus by dividends on their stock.

On the other hand not only have we the actual saving in the transformation of the potential energy of the coal into heat energy by this chain of changes, but also we must take into account the fact that with an electrical cooking device no fire need be prepared for hours before it is in the proper condition for cooking and maintained constantly after these operations are completed, but the heat rises within a few minutes after the current is turned on, and when the switch is turned off no further current is consumed.

Experiments have been made on the cost of cooking in this manner by an English electrician, and he states in a most elaborate paper the cost of toasting a slice of bread or of boiling an egg, but no such results can be of much value in determining at what cost our own servants are able to perform these operations. That the cost at present is not as great as by gas cooking seems well established, and we may hope soon to have reliable results from the practical operation of some of the recently established electrical kitchens.

But now it is morning, and we must not forget that to-day we are to visit our host's office, where he has further electrical wonders for our inspection. Our bed-room lamp lights itself promptly at rising time, and, dressing ourselves by its light, we descend to breakfast, where further use is made of electrical heating in preparing our coffee and eggs; but at last we must bid adieu to the hostess and her ever ready slave, electricity, to visit our friend at his place of business.

He is a busy, hard-worked man, and has his office spread over half a floor in one of our tall office buildings; under his control are many sub-departments and numbers of clerks driving along that great mental engine, the financial department of a large business.

Entering the building, we are at first conducted to the basement, where we find an electric-light station capable of furnishing lights enough for a small town, but which has only sufficient power for generating the current required in this one building.

While we are admiring the great engines and bright tiled floors and walls of the dynamo-room, we must not allow the mechanism of the electric elevators to escape our eyes. There are two styles of these machines near us, operating different cars. The older of the two is arranged like the hoisting engines which are to be seen on every dock and in every freight yard, with the single difference that in place of a steam-engine driving the drum on which the hoisting rope is coiled there is an electric motor, the shaft of which is connected with the drum through a train of gearing to reduce the high speed of the armature shaft in order to give the proper revolution speed to the winding drum.

But the later form of elevator mechanism is far more novel, though somewhat resembling the mechanism of a hydraulic elevator. To the shaft of the electric motor is connected directly a very long screw on which is a large nut running between guides and carrying a set of iron grooved wheels. Over these wheels and over a corresponding set of stationary wheels at the end of the machine the hoisting rope of the elevator is passed, making as many complete turns as there are pairs of stationary and movable sheaves.

When now the current is turned on and the motor moves, the screw revolving with the armature carries its nut either forward or back. If the motor moves forward and the nut carrying the sheaves moves away from the stationary sheaves, the rope is drawn out between them and the car ascends; but if the direction of the motion is reversed and the sheaves are moved nearer to each other, the car falls just as it would had the power been hydraulic in place of electric. Here, too, in one corner of the cellar is a large fan driven by electricity, which forces either hot or cold air—according as the register may be turned—into all the rooms of the building through a double set of pipes, through one of which the air passes over coils carrying the exhaust steam from the engine.

But now taking the elevator to our friend's office, we find many conveniences to lessen the labor of a busy day ready at his hand. We at first notice that this desk lacks the usual array of push-buttons for calling the heads of departments which are so much in evidence in many desks and are so confusing in a large office. But on our remarking their absence it is at once explained to us that the little dial which we see among the pigeon-holes in the front of the desk has the name of every man in the office printed upon it, and, when the pointer attached to the hand over the face of the dial is above a man's name, pushing the button in the center of the dial will call the clerk desired.

"This 'teleseme,' as it is called, is convenient when I wish a man to come to me," explains our friend, "but I seldom use it, for this device here is better." And turning to his telephone he explains the latest desk switch-board.

Many offices have been fitted with telephones from desk to desk with their wires leading to a central exchange where an operator sits to make connections from one to another, but with this device each one has complete control of the wires over which he is talking. A contact plug is attached to the telephone, and on the desk is arranged a bank of plug holes and annunciator-drops connecting with each man in the office who has a telephone. Pushing the plug into one of the plug holes and pressing a button calls the clerk to his telephone, while, if it is desired that the clerk be not allowed to call his employer, the corresponding annunciator-drop is omitted from the employer's desk. In this way a chief may arrange to call or be called by just those of his subordinates he may desire. Should he desire to talk to two or more clerks at the same time, he has but to call them up, and, changing his contact plug from one hole to another, talk to each without possible interference from the others who are waiting till he speaks again ; thus permitting conversations, consultations, and cross-questionings without obliging any of the participants to move from their desks, and without disturbing the telephone communication of the rest of the office.

But the electric dial which tells the correct time being actuated by the great self-winding clock in the hall below tells us that we have already taken much of a busy man's morning, and now, much impressed by the ingenuity of these devices, great and small, we leave him dictating the letters of the day to his phonograph.

Hardly realizing that this man may yet before the day is out be talking to a business house in Chicago, hearing that his commission given a few minutes ago has been executed in Australia, or writing a letter which is at once reproduced in his own handwriting in Boston. All of this, too, without leaving his office or even moving from his desk.

THE DEVELOPMENT OF THE MODERN STEAM PUMPING-ENGINE—II.

By William M. Barr, M. Am. Soc. M. E.

IT has always been a favorite project, especially in pumping operations, to convert intermittent into continuous, and reciprocating into rotary, motion. Serviere, a Frenchman, born in 1593, made during his lifetime a large collection of mechanical models, and among them were included machines for raising water. The rotary pump illustrated near the end of the previous article was included in this collection; it is the oldest, simplest, and in some respects the best rotary pump yet devised, consisting only of two toothed wheels gearing into each other. The water, entering in the direction of the arrow, passes around the peripheries of the wheels to the upper center, and is there prevented from returning by the contact of the wheels. These wheels are sometimes made up of segments of two radii so arranged that one extended segment shall roll into the opposite space, thus affording larger water spaces around the periphery of the wheel, the exact centering of these segmental wheels being secured by toothed wheels keyed to the driving shaft outside of the case.

The rotary or revolving piston pump has one good quality in common with the centrifugal pump in not changing the direction of the flow of water, which permits a high speed of revolution of the geared, or other form of piston. This continuous flow through the pump dispenses with the necessity for either inlet or discharge valves, making it a simple and effective pump for handling perfectly clean liquids.

The designs for rotary pumps are very numerous, a favorite one being the movement of a sliding piston through a turning block located eccentrically to the interior of the pump. In other designs two or more sliding pistons are employed which slide into, but do not pass through the turning block; but whatever the design there is usually such a complication of sliding parts, levers, etc., that the pumps are costly to make, and are not always durable in service. As compared with the centrifugal pump, the rotary pump has the advantage of being able to force water under a high pressure, and for this reason pumps of this class have long been in favor as fire-pumps, not only for factories, but mounted on wheels like other steam fire-engines.

The principal objection to the rotary pump is that, except when new, it does not have a high efficiency—scarcely more than 50 per cent.—at best; and this is quickly lowered by the destructive wear occasioned by contact action of the revolving pistons upon each other and upon the case. This wear soon makes them noisy as well as leaky; and by reason of the wear upon the interior of the case, it can be repaired only by reboring; and this often necessitates furnishing new pistons as well. Nor are rotary pumps, in general, well adapted for gritty water, especially when the pump consists of two toothed wheels working together. Water containing floating matter such as would pass through a centrifugal pump unnoticed would not pass through a rotary pump (excepting only a very few of special construction) without danger of breakage.

The low efficiency of rotary pumps has been explained as arising from the inertia of the water, or the difficulty of putting the water in motion from a state of rest, and imparting to it a high velocity as it passes through the pump, thus requiring the expenditure of more power than is later represented in useful effect.

To the famous mathematician Euler probably belongs the honor of having invented the centrifugal pump; but no immediate application of it seems to have followed the publication of his paper on the subject in 1754. The modern centrifugal pump is probably of American origin, one having been erected by Mr. McCarty in the navy yard at New York, in 1830, which was subsequently improved upon by Andrews in this country, and Appold, Thomson, and Gwynne, in England.

All centrifugal pumps are constructed upon one general principle, consisting of a fixed case within which revolves a "fan," the water entering at the center and being discharged at the periphery of the fan blades into a spiral chamber which terminates in a delivery pipe tangent to the fan-circle. The blades of the fan were originally straight and radial. At the great exhibition in London in 1851, Appold introduced his centrifugal pump, in which the blades were curved backwards, with the result that nearly three times as much water was discharged as was the case when straight blades were used. Since that time curved blades have been universally adopted.

Centrifugal pumps are best adapted for handling large volumes of water on low lifts, and are now almost wholly confined to such service. By reason of their extreme simplicity of construction, pumps of this kind can be made at lower cost than any other yielding similar delivery. The flow of water through a centrifugal pump is continuous, and the velocity nearly uniform; the entire absence of reciprocating parts, valves, and the like, enables the "fan" to be run at a high rate of revolution. There is a speed at which each pump will a little more than balance the weight of water between the lower and the higher or discharge levels. With this as a starting point, it is to be expected that an increase of velocity will give an increased discharge, but observations show that the increase does not follow directly as the speed, the economical lift and delivery being reached when the atmospheric pressure is wholly utilized; that is to say, when thirty-four feet of total lift is had. For purposes of irrigation, drainage, emptying of docks, coffer-dams, and excavations generally, these pumps are well suited, partly because of the large volume of water that can be transferred quickly, and partly because sand, gravel, stones, sticks, etc., will pass through centrifugal pumps without the liability of accidents to which other forms of pumping machinery are liable.

The efficiency of centrifugal pumps, obtained by dividing the water horse-power by the indicated horse-power, rarely exceeds 65 per cent. The engine for operating may be either simple or compound, depending upon the size of the pump, the permanence of the work, and the value of the fuel used. For lifting a large volume of water to a moderate height the centrifugal pump stands unrivaled in point of simplicity, compactness, and low first cost; but in point of durability and percentage of efficiency it does not equal the reciprocating pump.

The direct-acting steam pump, if we except Bull's Cornish pump, is an American invention, the credit belonging to the late Henry R. Worthington, who patented in 1841 a direct-acting steam pump. This patent covered a method of operating the slide valve without the aid of the momentum of moving parts. In addition to moving the water under pressure the steam power was exerted in compressing a spiral spring, through a suitable mechanism, without disturbing the steam valve, until the piston reached the end of the stroke; then the spring was released, the valve moved to the other end of the steam chest, uncovering the opposite ports and reversing the action of the engine, when a corresponding compression, release, and reversal occurred, making the engine automatic.

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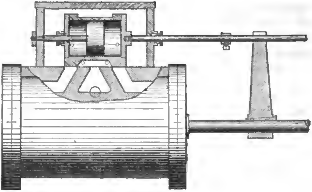
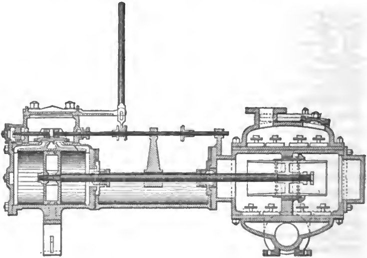
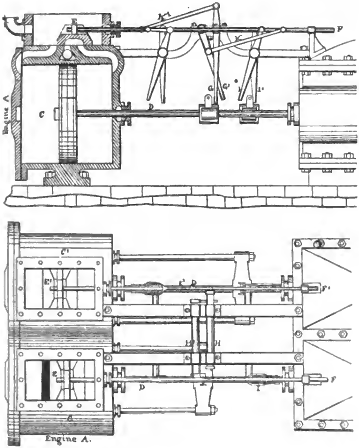


STEAM-THROWN VALVE.

As might have been expected, such a crude device as this could not long satisfy such a man as Mr. Worthington; and his next invention was the employment of a small steam piston for moving the main steam valve, as shown in the engraving. This auxiliary piston was acted upon by an auxiliary valve not shown in the diagram, an omission easily supplied by the reader. From this time forward steam-thrown valves for direct acting engines were



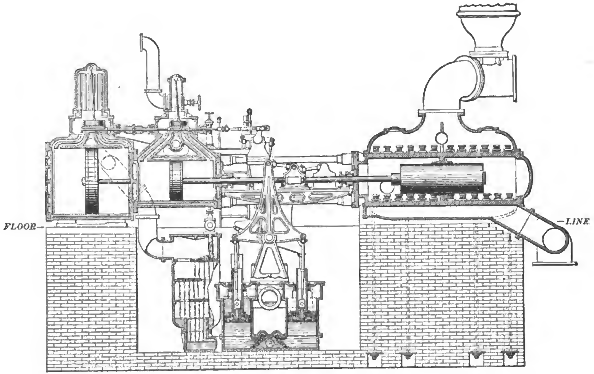
B SLIDE VALVE WITH POSITIVE MOTION.



ORIGINAL DUPLEX VALVE MOTION.

plentifully designed, and patents issued in great number, some being of considerable merit, others less so.

Ingenious and sufficient as was this steam-thrown valve motion, it was soon abandoned by its inventor, through an incident related by him which is well worth repeating. Mr. Worthington enjoyed the friendship of two eminent engineers of his day,—James P. Allaire and Arthur Stillman,—each of whom manifested considerable interest in the new pump, and upon its completion examined it with great care. Mr. Allaire nearly reduced his friend, the in-



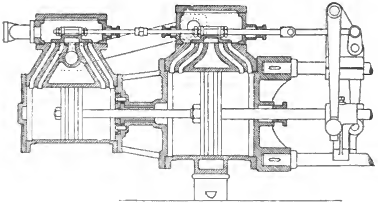
COMPOUND CONDENSING ENGINE.

ventor of the new pump, to hopeless inaction, by saying that "he considered it his duty to tell him that he was trying to invent a machine that was not wanted; and that no part of the machinery either of steamboats or for factory purposes was more satisfactory and complete than that for pumping." Nor did he fare better through the advice of his friend Mr. Stillman, who said, "This is all very well, and very ingenious, but, if you expect to bring these things into general use, you must contrive to have a man see something he has seen before in his life, when he takes the cover off from the steam chest." This well-meant advice was conclusive, and Mr. Worthington immediately set about inventing another valve-motion, which he patented in 1849, one which fully met Mr. Stillman's suggestion. This valve-motion, in its modified form, is shown in the engraving; the *B* or double cavity valve was probably first used on this pump.

Other builders of direct-acting steam pumps did not share Mr. Worthington's anxiety in regard to the future of the steam-thrown valve; the popularity of the Knowles steam pump, for example, more intricate in its detail than Worthington's, steadily grew, in face of the fact that engineers did not then understand its construction; and, in general, it is doubtful whether this valve motion is any better understood to-day; the superior excellence of workmanship alone, by which was insured certainty of movement, more than anything else carried this pump over the first quarter of a century after its introduction.

The Duplex steam pump and valve motion, as patented by Mr. Worthington in 1859, is herewith illustrated. To one who has not analyzed its peculiarities, there is no seeming resemblance to that of the duplex pump of to-day; but it is, in all essentials, the same. Steam cylinders with five ports, the two outer ones for the steam, and the three inner ones for the exhaust, were added later, and with this addition the duplex pumping-engine became practically a perfected machine.

A direct-acting engine without any provision for using steam expansively must, from the nature of the case, be extremely wasteful of fuel. Economy, then, compelled the use of compound steam-cylinders, especially for city water-works and other large installations. An illustration of such an engine is given opposite, together with the condensing apparatus and air-pumps. Engines of this class, compound condensing, of about ten million gallons daily capacity (24 hours), using steam at 90 pounds boiler pressure,



TANDEM COMPOUND VALVE MOTION.

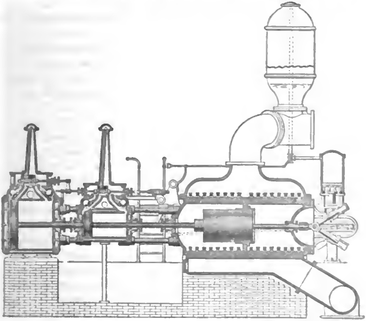
with three expansions, will yield an average duty of about 60,000,000 foot-pounds for each 100 pounds of coal burned.

For smaller engines, say two millions of gallons in twenty-four hours, the steam-cylinders are commonly arranged as shown in the engraving. Engines of this size are not always fitted with condensing apparatus. The low-pressure cylinder ranges from two to three volumes that of the high pressure. The steam pressures are commonly from 75 to 90 pounds at the boiler. The duty of such an engine, when non-condensing, is about 25,000,000 foot-pounds per 100 pounds of coal burnt.

What is true of the duplex pumping-engine in the matter of duty applies equally to all forms of direct-acting engines in which steam expansion can only be secured through the medium of high and low pressure cylinders using steam full stroke. The low duty of this class of engines is due to the want of a suitable mechanism by which a greater degree of expansion may be secured, and which for many years was not believed to be possible. For this reason the attention of engineers was almost wholly withdrawn from engines of this type, and directed toward some other form, especially the compound condensing rotative engine, fitted with either an adjustable or an automatic cut-off; engines in which could be utilized the well-known properties of the fly-wheel, securing thereby the advantages of a higher steam pressure and a greater degree of expansion. It was also believed that certain economies would accrue if a higher ratio of piston speed to that of the water plunger were employed. The compound pumping-engine of five million gallons daily capacity, designed by E. D. Leavitt, and erected at Lynn, Mass., in 1873, was of the crank and fly-wheel type; and it greatly surpassed, at the time of its erection, the duty of any pumping-engine ever erected in this country; the officially reported duty being 103,923,215 foot-pounds of work done for every 100 pounds of coal fed into the furnaces.

This remarkable performance was exceeded by a compound pumping-engine, also of the crank and fly-wheel type, of three millions of gallons daily capacity, designed by George H. Corliss, and erected at Pawtucket, Rhode Island, in 1878, the official report of a 24-hours trial being that 133,522,060 foot-pounds of work were accomplished for each 100 pounds of coal burnt.

A compound crank and fly-wheel pumping engine designed by H. F. Gaskill, erected at Washington in 1888, with a capacity of 2,500,000 gallons in twenty-four hours, yielded 101,772,977 foot-pounds of duty per 100 pounds of coal burned. Larger engines on this same general design have given better results than the above.



HIGH DUTY DIRECT ACTING PUMPING-ENGINE.

The advantages of high steam-pressure, and the corresponding number of expansions which may be secured, were well illustrated in a pair of triple-expansion crank and fly-wheel engines designed by Edwin Reynolds, and erected in Chicago in 1890, the combined pumping capacity of the two engines being 10,000,000 gallons in twenty-four hours. A net duty of 137,608,346 foot-pounds of work done per 100 pounds of coal burnt was the resultant record when the initial steam-pressure was 125 pounds. The water used was 12.675 pounds per indicated horse-power per hour.

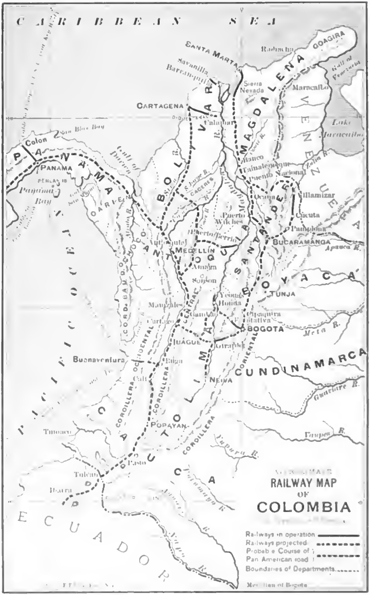
To return to the direct-acting engine after quoting such figures is accompanied by something akin to weariness; but mention must be made that inventors were engaged upon the problem of securing a high-duty attachment for the direct-acting engine, by which its economy should be greatly increased even though it fell short of the highest duty of the compound crank and fly-wheel engine. Such names as Morrison, Cameron, Davies, Davey, Fielding, Blake, D'Auria, Groshon, and especially C. C. Worthington, son of the late Henry R. Worthington, deserve especial mention. To Davey, in England, and Worthington, in this country, is due high praise for the intelligent and vigorous manner in which their inventions have been pushed toward completion.

A remarkable adaptation of the Worthington direct-acting high-duty pumping-engine occurs at Olean, Pennsylvania, in one of the pumping stations of the Standard Oil pipe-line. It is a duplex engine of the Tandem compound type. The steam-cylinders are 33 and 66 inches in diameter, the pump plungers 9½ inches in diameter, all of 37⅝ inches stroke. The work required of this engine is to pump about 1,250,000 gallons of oil in twenty-four hours, against an average pressure of 860 pounds, but which sometimes reaches 900 pounds per square inch. The boiler pressure is kept at about 90 pounds; the average steam pressure during admission to the high-pressure cylinder is 74 pounds;—average piston travel 126 feet per minute. The foot-pounds of duty per 100 pounds of anthracite coal at average rate of evaporation, under working conditions, were 110,943,000. If the boilers had evaporated ten pounds of water per pound of coal, the duty would have been 116,500,000 foot-pounds. The total indicated horse-power was 457, the water consumption was 16.4 pounds per indicated horse-power per hour.

A compound duplex pumping-engine with Worthington's high-duty attachment, made in England, the principal dimensions being 27-, and 54-inch steam-cylinders, 40-inch plungers, all of 44-inch stroke, indicating 255.5 horse-power when delivering 13,407 English gallons per minute, on the unusually low lift of 53.68 feet, gave a duty of 106,010,000 foot pounds of work for each 112 pounds of coal burnt. The mechanical efficiency of the engine and pump was 0.8495. The piston speed was 124 feet per minute. The feed-water was 14.9 pounds per indicated horse-power per hour.

From the above it will be seen that the direct acting engine with high duty attachment is now fully abreast its once formidable rival, the crank and fly-wheel engine, and that under similar and average conditions the economy of each may be assumed to be equal.

No one knows what a day may bring forth. The present indications do not point to a speedy adjustment of the difficult problems of deep-mine pumping, in which the resources of the steam engineer seem to be well-nigh exhausted. Electricity, working wonders in so many directions, in its practical applications does not yet promise economical results in mining-pumps beyond those now attained by steam. Compressed air as an agent for the removal of water from mines is wanting in sufficient and accurate data upon which to venture an opinion as to its future. For water-works supply the mechanism of pumping machinery is on a high plane of excellence and economy. Two distinct types—the direct-acting and the rotative high-duty engines—will compete side by side with about equal claims for high economy; the water-ends, provided with mechanically operated valves, practically solve that problem.


CARIBBEAN SEA
SANTA MARTA
GOAGIRA
Riohacha
Gulf of Venezuela
Savanilla
Barranquilla
Sierra Nevada
Marcaibo
CARTAGENA
Calamar
Lake Maracaibo
MAGDALENA
VENEZUELA
Colon
San Blas Bay
PANAMA
Panama
Perlas Is.
Panama Bay
Gulf of Darien
DARIEN
BOLIVAR
Banco
Tamalameque
Puerto Nacional
Ocaña
Villamizar
Cucuta
Pamplona
Zulia R.
S. Jorge R.
CACERES
Puerto Wilches
Puerto Berrio
BUCARAMANGA
Apure R.
SANTANDER
Antioquia
MEDELLIN
ANTIOQUIA
Amaga
Sonson
BOYACA
TUNJA
CORDILLERA OCCIDENTAL
CENTRAL
Manizales
Honda
Ambalema
Zipaquira
Facatativa
Cartago
BOGOTA
Meta R.
IBAGUE
Girardot
ORIENTAL
Buenaventura
Buga
Cali
CUNDINAMARCA
NEIVA
Guaviare R.
PACIFIC OCEAN
TOLIMA
CORDILLERA
POPAYAN
CAUCA
Vaupes R.
Tumaco
Yapura R.
Pasto
Tulcan
Ibarra
ECUADOR
RAILWAY MAP
OF
COLOMBIA
Railways in operation
Railways projected
Probable Course of Pan American road
Boundaries of Departments
Meridian of Bogota

RAILROAD DEVELOPMENT OF COLOMBIA.

By Juan de la C. Posada, B. S.

THE accumulation of capital in the United States, the development of industries until the home demand for their products has been more than supplied, and the crowding of the professions, have combined to create an interest in the prospecting of other countries, where some of this extra energy, as it were, may profitably be expended. Latin America, with its immense and varied fields for enterprise, is attracting a share of this attention. It gives me, therefore, much pleasure to comply with the invitation of the editor of this Magazine to contribute something toward a better knowledge of my native country, the Republic of Colombia, and the opportunities for engaging in business in this rich section of the world.

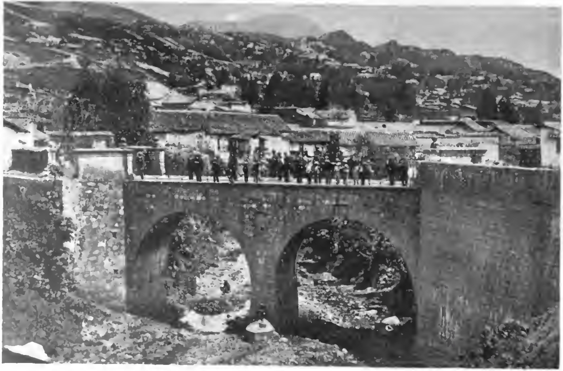
Colombia embraces an area of over half a million square miles, with upwards of 2500 miles of coast-line on the Caribbean sea and Pacific ocean. Just at the beginning of the war of independence, in 1810, the population was estimated at 1,000,000, and shortly after the end of that sanguine struggle, in 1825, the census returned 1,223,598 inhabitants. In an accompanying table is shown the growth of the country in population in the period between 1843 and 1881, and the area of the several political divisions—called "Departments" since 1886—which compose the republic of Colombia. There has been no general census lately, but at the rate of increase indicated by the table the population must now ap-

DEPARTMENT.	Population 1843.	Population 1881.	Area in square miles.	Inhabitants per square mile.	Number of years to duplicate the population.
Antioquia........	189 000	470,000	22,790	20 7	25
Bolivar...........	192,000	320,000	27,027	11.9	56
Boyacá...........	332,000	666,000	33,321	19.4	37
Cauca............	268,000	614,000	233,132	2.7	30
Cundinamarca...	279,000	563,000	79,693	7.1	37
Magdalena........	62,000	150,000	26,950	5.5	27
Panamá..........	120,000	285 000	31,892	8.9	27
Santander........	306,000	546,000	16,293	33.5	48
Tolima...........	183,000	306,000	18,417	16.5	56
Territories	......	80,000	24,402	3 2	..
Totals..........	1,931,000	4 00,0000	513,917	7.8	36

COMUN BRIDGE.

proach very nearly to 5,000,000. To one familiar with the natural growth of the human race as a whole, these figures speak well for Colombia, when we consider that the factor of immigration has been inappreciable, the foreigners settling in that country during all this period not exceeding a few hundred. Indeed, the United States probably would not have made better showing had immigration been stopped fifty years ago. At present not more than 100,000 square miles of the total area of Colombia are inhabited, which would give an average of about fifty souls per square mile ; while taking the country as a whole we find only eight to the mile. There is no question as to the possibility of sheltering comfortably as dense a population as that of Europe, which would give Colombia 42,000,000 people. The same average density as the United States would give a population of 10,000,000.

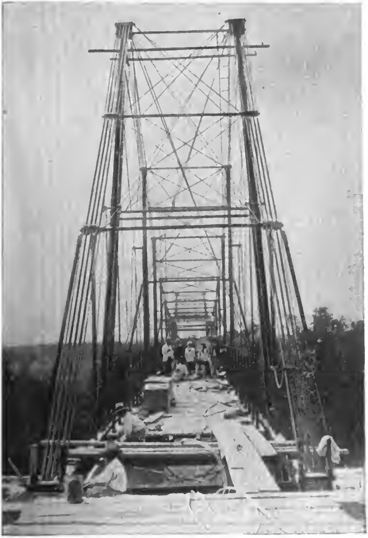
There are yet some 200,000 savage Indians in the country, but these give little trouble. The rest of the population is made up of whites of the Latin race, Indians, negroes, and mixtures of all of these. The whites and civilized Indians are generally found in the mountains, at elevations of from 3000 to 9000 feet ; while the negroes—who were freed from slavery long before those of the United States—prefer the lower valleys and the coast. As it makes a material difference to a foreigner as to what department he may locate in, it may be well to study the distribution of the people throughout the country. In Antioquia, an exceedingly



COLON BRIDGE, BOGOTÁ, COLOMBIA.

mountainous region, healthy, rich in mines, and rather sterile as to the soil, the inhabitants are almost all white, with unmistakable traces of Hebraic blood. They are considered by representative travelers as among the most energetic and enterprising people of the country. Some negroes and few Indians are found, but foreigners are rare. In Bolivar the whites also predominate, but there is a good percentage of negroes and mixed people. In this department are situated the main Atlantic ports, in which exists a small colony of foreign merchants. The land is fertile, low, and flat, but the climate is warm and generally unhealthy for new-

SAN FRANCISCO BRIDGE, BOGOTÁ.



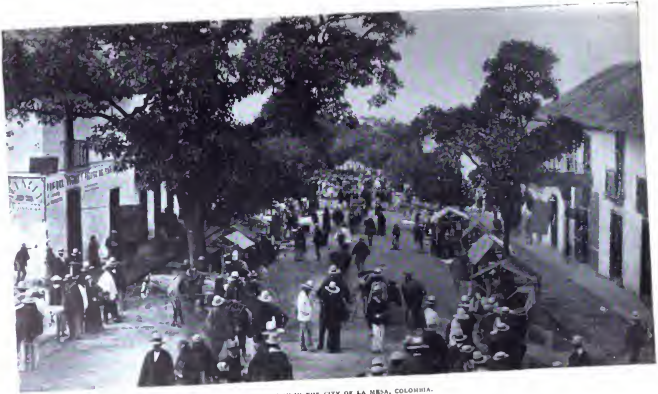
BRIDGE OVER THE MAGDALENA AT GIRARDOT.

comers. Boyacá has a large majority of pure and mixed natives, living in the high, healthy, and fertile plateaus of the eastern Cordillera. They are considered good and obedient soldiers. Cauca

GIRARDOT STATION ON THE GIRARDOT RAILROAD.

shows a large number of whites, with many pure negroes in the Cauca valley and Indians in the south and southwest. The land here is the most promising to be found in the republic, and within the immense territory of the department are to be found all the varieties of climate in the world. Cundinamarca is like Boyacá in almost all respects. Here we find the city of Bogotá, the capital of the republic, and the most cultured and populous center. Magdalena has undoubtedly the most energetic Indians in the whole country—the "Goagirans." In other respects the department is similar to Bolivar, and the Sierra Nevada region is a healthy and promising one. In Panamá the negroes, Indians, and mixtures predominate. There are quite a number of foreigners, especially merchants. The land produces almost everything, but the climate is generally unhealthy. The inhabitants of Santander are among the most enterprising of the country, and there is not a very large percentage of mixed people. Foreign merchants, and especially the Germans, are prospering here. Its coffee industry takes first place in Colombia. Tolima is the newest of the departments, and is being rapidly populated by Antioquians in the northern mining region. There is no doubt of the bright future for this section, rich in mineral and agricultural products.

Although the upper classes are not as cultured in some respects as Europeans in similar circumstances, they are considered by unprejudiced travelers as well-educated and well-mannered, intelli-



MARKET DAY IN THE CITY OF LA MESA, COLOMBIA.

gent, anxious for progress and enlightenment, patriotic, hospitable, festive, and very sensitive. To be sure, they do not display the enterprise in business that is so characteristic of the people of the temperate zones, and more especially of the Saxon races. That ambition for the accumulation of dollars and the consequent uneasy and restless kind of life of the average business man of the United States is not a quality of Colombians. Nevertheless, under the circumstances in which the country was born and is growing, little more could be expected than what has been accomplished. In the colonial times, by force and by nature, we were obliged to live in the darkness; under our free government, the unhappy political struggles and personal ambitions have been no less a barrier to our progress. Besides, the nature of the country is such as to keep us isolated from the rest of the world far away in the interior of a country of difficult access. The lower classes of the people, especially those living in the mountains, are characteristic for their simple habits, probity, and hospitality, and are not lacking in industrial abilities and habits. In the low valleys and the coast, where the negroes abound, the people are more or less indolent, and even the Europeans who settle in those regions lose a great deal of their energy under our climate.

In fashions and ideas the people are more inclined to follow

SANTANDER BRIDGE, BOGOTÁ, AND MONSERRATE MOUNTAIN.

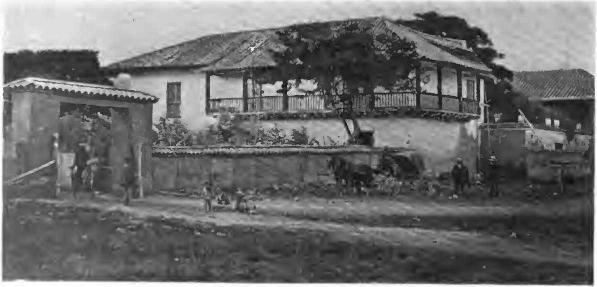
SEIBA TREES AT JUNTAS DE APALO—MULES RESTING—COCOA PACKS.

HOTEL AT COMUN BRIDGE.

France than any other country ; but there is no prejudice against other nationalities, and all those who care to try their fortunes in Colombia are equally welcomed and respected, provided they do not mix in low politics, while under the flag of their fatherland. If there is found some prejudice in certain quarters, it must be attributed to this cause or to the swindlers and adventurers of all sorts who happen to take advantage of the simplicity of the people. It is hoped that the uninterrupted peace enjoyed since 1886, when the centralized form of republican government was established, will continue.

The question will naturally arise as to what lines of enterprise would benefit foreign investors, what channels of commerce are more promising, and what is it that these people need more from without. In answer I will give some suggestions, for whatever merit they may have, as expressing the sentiments of many Colombians, as I understand them.

The great drawback to present advancement, and the one most keenly felt by all classes of people, is the lack of a system of railways. As there is not money in the country for these costly improvements, efforts have been made, time and again, to interest foreign syndicates, but as yet little has been accomplished, in spite of many "concessions," some of which have been ruinous for the country. Railways have been projected, contracts made, work begun here and there and then suspended, all in a more or less reckless fashion, injuring not only those immediately interested,



A FARM-HOUSE IN COLOMBIA.

but the cause of railways in general. Had a more conscientious study been made of the lines most needed, and more earnest and persevering work carried out to surmount the great natural obstacles, Bogotá, Medellin, Cali, and Bucaramanga might be to-day in rapid communication with the civilized world. As it is, most of these centers are *farther away from our own ports* than is Honolulu from New York. It may not be amiss to give here a short sketch of the Colombian railroads and the regions traversed. The map accompanying this paper is referred to.

I. THE PANAMÁ RAILROAD.—A concession was granted in 1850 to New York capitalists and the road was completed in 1855, the length being 47.5 miles, from Colon to Panamá, at a cost of $7,500,000. In 1887 the stock was sold to the Panamá Canal Company. This road is complete in itself, and the best equipped in the country. It pays high dividends, but charges unreasonable tariffs. It is not likely that more roads across the isthmus will be needed in the near future; and one for local traffic along its entire length of 400 miles would prove a failure now. Such a railway would be, however, a link in the proposed Pan-American road. The entire northern coast of Panamá is warm, damp, unhealthy, very rainy,

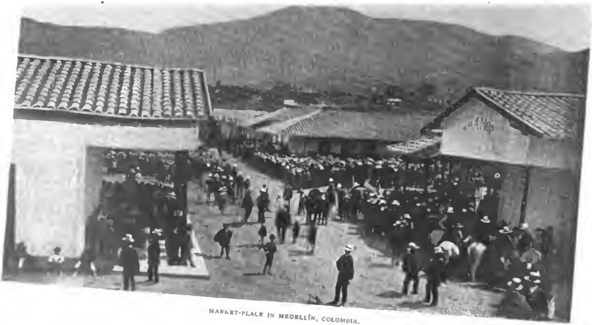
A TRAIN ON THE GIRARDOT RAILROAD.

CHAPINERO, NEAR BOGOTÁ, COLOMBIA.

STEAMBOAT ON THE MAGDALENA RIVER.

and almost uninhabited, except by Indians. The mountains back of it, rising a few hundred feet, are wooded, fertile, colder, and much healthier. As yet they are also wild. The San Blas district has some 30,000 Indians, with an export trade of $150,000, especially in cocoanuts of excellent quality. The opening of the hills in this and other districts along the same coast for plantations of cocoanuts, cacao, bananas, and coffee, and the raising of cattle, is inviting. Cabinet woods are abundant. Easy landings are numerous. Already some colonies are prospering. The Pacific coast, from Panamá to Costa Rica, is warm, but generally healthy, the country being free from lagoons and marshes. The hillsides are cereal- and fruit-bearing, cultivated, and well watered. This is the most densely-populated portion of the isthmus. South of the city of Panamá the coast is unhealthy, the mountains unknown, and soon that dreadful and wild region of Darien and lower Atrato valley is reached. This is reported to be rich in mines of gold, platinum, etc.; but with its nine months of rain and terrible thunder-storms, its poisonous creatures of all sorts, the few settlements, and wild Indians, it cannot be inviting for northern people.

II. THE BOLIVAR RAILROAD.—This was contracted for in 1867 by Colombians, and completed in 1870 by a German syndicate. It



MARKET-PLACE IN MEDELLÍN, COLOMBIA.

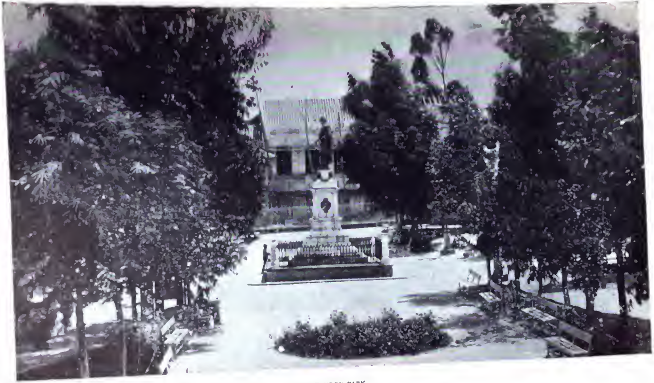
was bought in 1875 by the government for $600,000 and sold again to a Colombian company in 1884 for $684,000. It connects Barranquilla, on a narrow arm of the Magdalena, with the harbor of Savanilla, at a point called Puerto Colombia, 16.8 miles distant. It is a 3'-6"-gage road, in fairly good condition, transporting the greater part of the trade of Colombia at reasonable rates.

III. THE CARTAGENA RAILROAD.—Projected since 1865, and intended to connect the harbor of Cartagena with the Magdalena river, it is only within the last three years that the actual work of construction has been in progress, under the auspices of the Cartagena Terminal and Improvement Company of the United States. It is reported as nearing completion, with its terminal at Calamar, about 50 miles distant, on the banks of the Magdalena.

IV. THE SANTA MARTA RAILROAD.—June, 1881, was the date of the first contract for this line, to connect the harbor of Santa Marta with the Magdalena river. It is now in the hands of an English company, and has been completed for some 30 miles from Santa Marta towards Peñon (106 miles) or Banco, a town of some importance on the right bank of the river, and about 220 miles from Santa Marta.

Each of the last three lines has the same general object,—to connect the coast with our great interior water-way. Which one will

A STREET IN BOGOTÁ, COLOMBIA.



SANTANDER PARK.

RURAL SCENE IN COLOMBIA.

have the most success of course is impossible to say. The Bolivar road is the shortest, already in operation, and has connection with Barranquilla, 30,000 inhabitants with large commercial establishments, machine-shops for the steamboat companies plying the river, etc. But the harbor of Savanilla is not always safe, being open at the west and southwest, and so shallow that regular ocean steamers cannot yet reach the pier in process of construction, although it is several hundred feet in length. The Cartagena road has to compete with the navigation of the Dique canal, which is, however, very unsatisfactory and uncertain. Otherwise, the harbor of Cartagena is one of the best on that coast of South America, and needs only some $1,500,000 in improvements to make it first-class. The city has 10,000 inhabitants, is comparatively healthy, and its trade has already largely increased. The terminal point on the river is a town of little importance. The third line has also a good harbor at Santa Marta, with deep water and generally safe. The city, with 5000 inhabitants, has seen better times, however, and few vessels touch there now. The railroad would be longer than the others, but crossing a country of superior resources. It will stretch along the western foothills of the Sierra Nevada, an isolated mountain over 17,000 feet high. Going from the foot of it to the top, a person would experience all the climates of the world, from the equator to the poles. The same thing is true as regards agricultural possibilities.

SCENE IN CARTAGENA, COLOMBIA.

The region is very little protected yet and, one might say, almost wholly in possession of savages, some of them hostile. The valleys of the rivers Sevilla, Frio, Cataca, César, etc., are known to have produced gold, from placer and vein mines. Copper was also mined, and the deposits of Camperricho are remarkable for the abundance of mineral, purity of the copper, and good percentage of silver. But the coal deposits probably deserve more attention, as they would supply ocean steamers, the boats on the rivers, and the railroads around there. Good coal has been found on both the eastern and western slopes of the mountain. The Cerrejon district, on the east side, is about the most promising, being only 50 miles from the Atlantic, or the gulf of Venezuela. A coal basin of more than sixty square miles has been prospected and a 70 foot coal measure discovered, composed of ten alternating seams of sandstone and coal. On the line of the railroad, on the river Calata, a 3-foot seam has also been discovered. These coal fields are probably cretaceous. According to Karsten, massive crystalline rocks (amphibole granites, fine grained syenites, etc.), and schists, compose the great bulk of the Sierra, with cretaceous strata, partially metamorphosed, leaning against the Eastern and Southern slopes. The value of these mines cannot be overestimated. We are now importers of coal. In 1891–92 we imported from the United States alone 1400 tons of anthracite and 24,552 tons of bituminous coal. In conclusion, the departments of Bolivar and Magdalena possess excellent lands for plantations of cocoanuts, bananas, cacao, coffee, sugar-cane, and tobacco ; the forests are full of valuable products, and the Sierra region is also promising for mining. The completion and extension of these railroads and the introduction of desirable immigrants, under intelligent management and sufficient capital, would transform these rich lands into prosperous cities.

V. THE DORADA RAILROAD.—The navigation of the Magdalena river is interrupted by two important points,—at the mouth, on the Atlantic, where a bar of dangerous character would require millions of dollars to make the entrance of ocean ships safe, and up the river, some 610 miles, by dangerous rapids at Honda. To obviate the last obstacle the Dorado railroad was constructed, from the said point (at Arrancaplumas) to Yeguas, north of it a distance of thirteen miles. The first contract was made in 1879, but the road was only completed in 1884, and since 1887 has belonged to an English company. Lately there have been negotiations and some concessions for the extension of this line seven miles north of Yeguas, to a better port, and twenty-two miles south of Honda, to the port of Cambao, in communication with Bogotá by a wagon-road; also, from Cambao to the plains of Bogotá, and some projects to join Honda with Girardot by way of Guayabal, Santa Aña, Frias, and Tbagué, following the foot-hills of the Central Cordillera. This northern region of Tolima is important for its abundant mines and agricultural products. Good placers have been found and are in successful operation, some of them using hydraulic giants. Gold-quartz mining has taken much impetus lately, and rich silver mines are in successful working, as the Frias, where, with a jigging plant of modern style, some 80,000 ounces of silver have been obtained monthly—in recent times. Foreigners are largely interested in this region.[*] The tobacco industry is prospering, and the Ambalema product is well known abroad. Good lands for coffee and sugar-cane are abundant, and the climate in the slopes of the Cordilleras is delightful.

VI. THE GIRARDOT RAILROAD.—There is steamer connection between Honda and the port of Girardot, 90 miles up the river. Hence, a line from this place to the plateau of Bogotá would give an easy access to Colombia's capital from the Atlantic by a route 830 miles long, from Savanilla. The government has been much interested in the project for the last twelve years, but so far only twenty-five miles have been constructed,—from Girardot to Apulo. The work is now in the hands of an English syndicate and is being pushed with vigor. Engineering difficulties are numerous, ascending from 1080 feet of altitude to 8674, within ninety-three miles

VII. THE SABANA RAILROAD.—The high plateaus of Bogotá and

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[*] Accounts of the Tolima mining districts may be consulted in articles by Sr. F. P. Gamba, in "Anales de Tregemeria" (Bogotá), Vols. I, IV, and V. Also in the "Transactions of the American Institute of Mining Engineers," Vol. XVIII, p. 205—Mr. J. C. F. Randolph's "Notes on the Republic of Colombia." Although I have a great respect for so high an authority as Mr. Randolph, I take the liberty to qualify as somewhat exaggerated his statement as to the outlook for mining in Colombia. He says: "The Republic of Colombia does not offer an attractive, profitable, or safe field for foreign investments, and statements as to rich mines in that country should be received with more than ordinary caution." Not having space to give my reasons at length, I would simply remark that we were unfortunate in not having Mr. Randolph remain with us for a longer time and visit many other important mining districts of the country. There are now a good number of Colombian and foreign companies, fairly well organized and equipped, making money, in spite of the difficulties of pioneers. However, investors hoping for rich "bonanzas" and piles of gold, as in early California mining, may certainly keep away from the country. We have numerous and rich mines, but they require intelligent and scientific working, under most judicious management. We have been pursuing either of these two extremes; very primitive and wasteful methods, or extravagant plants, put up by men without practice and knowledge of the country, and designed by an engineer who, perhaps, does not even know where the country is. A medium between the two would be, undoubtedly, more desirable and safer.

RAFAEL NUNEZ,
President of Colombia.

DR. MIGUEL ANTONIO CARO,
Vice-president of Colombia.

Ubaté—probably formerly occupied by Quaternary lakes—embrace an area of more than 1500 square miles and 500,000 inhabitants. On the southern end, at the foot of the eastern Cordillera, lies Bogotá, a city of some 120,000 inhabitants, with most of the comforts of modern civilization. Twenty-five miles in a northwesterly direction, in the highway to Honda, near the point where the abrupt descent to the Magdalena begins, is found Facatativa, with 12,000 inhabitants. Between the two points the Sabana railroad was completed in 1889 by a Colombian company, employing Colombian engineers exclusively. The department of Cundinamarca has been in connection with the enterprise in some way since its initiation in 1881. Some extensions have been considered to points favorable for the junction with the lines in construction from the river. The road is in good condition, with regular service, and paying dividends.

VIII. THE DEL NORTE RAILROAD.—For more than twenty years there have been projects, surveys, and concessions for this line, as a whole or in portions, and following different routes. At present two divisions are in actual process of construction,—at the two ends and under different companies. When connected, however, they will form with their branches into important points in Santander, Boyacá, and Cundinamarca, the great natural northern route east of the Magdalena river, leaving the Girardot railroad as a link in the great western route to the Pacific ocean, but of little importance for the Atlantic trade with Bogotá. Of course the ultimate desire is to connect the Magdalena and the Del Norte lines, and studies have been made to this effect. The divisions in construction are : (*a*) the Cipaquirá, from Bogotá to the city of the first name, with 15,000 inhabitants, where large rock salt deposits are mined. The distance is 31 miles, and a few have already been constructed under the auspices of a Colombian company ; (*b*) the Santander railroad, 70 miles long, from Puerto Witches to the city of Bucaramanga, a commercial center with 20,000 inhabitants. This is being pushed ahead by an English company. Now, one of the lines advocated to join Bucaramanga and Cipaquirá is about 220 miles long, traversing a mountainous country, but of unlimited natural resources, very healthy, populated by an industrious people, and with some cities of importance, as Chiquimquirá, San Gil, Piedecuerta, etc. Coffee, sugar-cane, and other commodities could be produced of excellent quality in the lower lands, and wheat and potatoes, much needed in the country, could be made articles of exportation instead of importation, as is the case at present in Colombia. The raising of sheep in the high lands and the establishment of woolen factories is inviting. There is something of this now, and it only needs encouragement and facilities for transportation to give employment to a large number of people of the lower classes living in those mountains. Cotton lands are also abundant, and the erection of cotton mills for the manufacture of ordinary cloth deserves attention. The three departments of Boyacá, Santander, and Cundinamarca are likely to become the most important manufacturing sections in the country on account of the abundance of labor and the nature of the people and the country. Coal is abundant at many places, and iron is not scarce. The deposits of Samacá, Pacho, and La Pradera are well known. Of these, the most important at present are those at La Pradera, near Bogotá. A Colombian company, aided by the government, has erected in the last twelve years a large blast furnace and foundry-works, now in successful operation. The extent and possibilities of the enterprise may be judged from the fact that 70 tons of castings are turned out daily.

IX. THE CÚCUTA RAILROAD.—To connect Villamizar, a port on the river Zulia, with Cúcuta, a rich agricultural center,—and to-

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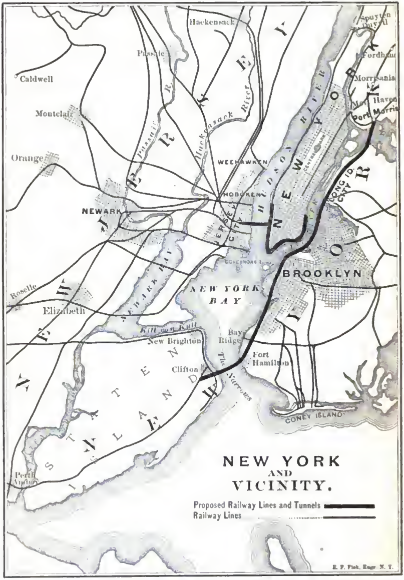
day the most active city of Santander,—a railroad was initiated in 1877 by a Colombian engineer, a national company was formed,—the city of Cúcuta representing one-third of the stock,—and the road was completed in 1888. Although only 34 miles long, it is of great importance for that section of the country, and has been an important factor in the development of the coffee industry, especially. Projects for the extension of this line to Pamplona and Bucaramanza on the one side and Ocaña and Puerto Nacional on the other have been in consideration several times. Lately a concession was granted to Colombians for the Ocaña-Puerto Nacional road, but I understand that it has changed hands, with as yet nothing important done. This section is attractive for plantations of all sorts ; the people are vigorous and enterprising.

X. The ANTIOQUIA RAILROAD.—At a distance of 125 miles from Puerto Berrio, on the Magdalena river, and in the heart of the central Cordillera, lies Medellin, with 45,000 inhabitants, the second city of Colombia, noted abroad for the substantial character of its commerce. Several efforts have been made within the past nineteen years to connect the two places by rail, with an expenditure of over $2,000,000 (Colombian coin) by the department, giving, however, only 29 1·5 miles as the actual result. Last year the departmental government obtained a loan in England and made a contract with the lenders for the construction of the road, and work is now going on enthusiastically. The road is now out of the swamps of the Magdalena, but is beginning to enter into a rough mountainous section. Once in the Porce valley, the difficulties will be greatly diminished, and the success of the enterprise practically assured.

XI. THE CAUCA RAILROAD.—From Buenaventura, our main port on the Pacific ocean, a line was projected as early as 1875, to the city of Cali, distant about 75 miles, and situated in the rich and beautiful Cauca valley. In 1878 the first rails were placed, and in 1882 the section from Buenaventura to San Cipriano, a distance of 16 miles, was ready for traffic, although in a poor and provisional way. Several other attempts have been made to finish the road and prolong it to the city of Manizalez (133 miles), near the border between Antioquia and Cauca, but little has been accomplished. At present a company formed in the United States is pushing this work, and an early completion is hoped for, at least as far as Cali, a commercial center in the department of Cauca.

The importance to Antioquia and Cauca of the completion of their respective roads to the ports of supply cannot be overestimated. If to these we add a railroad connection by way of Cartago and Amaza, following the Cauca valley as far as the creek Sinifaná, between the two important cities, Medellin and Cali, the commerce between the two departments could be largely increased, opening at the same time some of the most magnificent and promising regions for colonization and enterprises of all sorts. Sugar-cane, bananas, cacao, cocoanuts, etc., are produced in the Cauca valley as in very few spots in the world. The hillsides of the eastern and western Cordillera could supply coffee for millions of people, and the mines of Antioquia could give employment to a great portion of the surplus capital of North America. Even now, with mining generally in a crude way, the production of gold and silver is considerable; and the other metals are abundant, as well as coal of good quality. With the establishment of better transportation facilities, there will be undoubtedly a demand for engineers of every kind, mechanics, and experts in manufacturing; also for men with capital and good judgment to develop coffee-plantations, sugar-cane factories, etc. There is not now much need for laborers, clerks, or, in general, men without money, brains, or enterprise, but immigrants with these requisites, anxious to improve themselves and the country, are very much desired, provided they have not in mind the exploiting of the country through building up monopolies and curbing competition.



NEW YORK AND VICINITY.
Proposed Railway Lines and Tunnels
Railway Lines
Hackensack
Passaic
Caldwell
Montclair
Orange
NEWARK
Roselle
Elizabeth
Perth Amboy
Passaic R.
Hackensack River
WEEHAWKEN
HOBOKEN
JERSEY CITY
HUDSON RIVER
CENTRAL PARK
Spuyten Duyvil
Fordham
Morrisania
New Haven
Port Morris
LONG ID. CITY
BROOKLYN
GOVERNORS I.
NEW YORK BAY
NEWARK BAY
Kill von Kull
New Brighton
Clifton
The Narrows
Bay Ridge
Fort Hamilton
CONEY ISLAND
NEW JERSEY
NEW YORK
STATEN ISLAND
E. P. Fish, Engr. N. Y.

RAILWAY TERMINALS AND NEW YORK HARBOR.

By William Nelson Black.

IT may be safely said that no harbor of either ancient or modern times was purely a work of structural skill, and represented the ideal of engineering science or invention. Harbors grow into being; and they are more definitely fashioned on the lines of certain physical features by which they were originally distinguished than a result of any deliberate plan.

Take the harbor of Buffalo, at the foot of Lake Erie, as an example. Here is a work that may be called almost exclusively a product of civil engineering. Not even excepting the Black Rock section, formed at the head waters of the Niagara river by the stone pier parallel with the shore which enters into the construction of the Erie canal, this harbor is composed exclusively, it may be said, of basins, canals, and channels, some reclaimed from the great inland sea by the erection of sea-walls, some excavated from the solid soil at great labor and cost, and some dredged along the tortuous course of a shallow stream that once formed a fit paddling place for truant urchins who, stripped only to the knees, went in pursuit of tadpoles or other aquatic game. Yet it has grown into a harbor expansive enough and deep enough to shelter many hundred vessels of a class that would form no mean examples of marine architecture in any port of the world. It has now become one of the chief harbors of the continent, the product of a total expenditure of many millions of dollars. But the basis of Buffalo harbor was only Buffalo creek, and it still owes its chief features to that now apparently vanished stream.

While holding, however, that harbors and terminal works in the vicinity of harbors are largely a product of physical evolution, and are often such as circumstances and necessity dictate rather than a conception of engineering science, the writer would not like to be misunderstood. He does not wish to say that engineering science and invention will have less to do with results than natural forces. Skill and an ingenious faculty for arrangement must always remain the chief factors in the construction of good

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harbors and effective storage and forwarding appliances; and without this skill and adaptability in arrangement the strongest natural forces and the greatest natural advantages will be likely to produce very feeble results. Buffalo has been made an economical and efficient place for receiving and forwarding merchandise only because the skeleton on which the harbor was reared has been so overloaded with new tissue that the original lines are no longer to be traced.

Very different from the harbor of Buffalo both in natural features and development is the harbor of New York. Here is a harbor upon which nature had originally lavished every advantage. It is spacious almost to the extent of an inland sea, containing a surface of not far from fifty square miles of deep, navigable water, and it is perfectly landlocked and easy of access through two main channels leading in almost opposite directions, but both available for either coastwise or foreign traffic. Yet the harbor of New York impresses one as a harbor on which the hand of the civil engineer has never been exercised, and where nature has allied herself with shiftlessness to show that the science of engineering is a useless pretense. The work that is called engineering, on which the city of New York is now engaged, is not fit to be dignified by any such term. It was merely the conception of some political caucus casting about to find a plausible opening for the expenditure of money, and ready to see it in any scheme that looked defensible, however absurd.

What is really needed for the harbor of New York, when we consider it in all its relations, both shipping and terminal? This is a question of even more importance to-day than it would have been in the days when the name of the cluster of houses surrounding the Battery was New Amsterdam, and the first pile for the construction of the first pier had not yet been driven. It is a question of even greater importance now than then, indeed, for, on account of its location on the coast and other natural advantages, New York has become the chief seat of the commerce of the continent, and whatever affects the economy of its shipping operations is felt in the prices of commodities in the remotest parts of the Union. Nearly half the export traffic of the country, and more than half the import traffic, passes through the harbor of New York; and the city, united with the districts tributary to the harbor known collectively as the metropolitan district, has begun to take such a signal lead in manufacturing industry that it may be said to almost dictate the general cost of merchandise. Any question touching its terminal and shipping arrangements, then, is a national question, or, to use a safer word in these days of congressional usurpation, a continental question, and it should be of universal interest. What do the harbor of New York and the railways concentrating on the harbor need to enable them to meet the demands of the merchants and manufacturers of the metropolitan district in the economical handling of their merchandise and material?

Before attempting to answer this question it will be well to take a hasty look over the field and observe what is most defective in arrangement. At the very first glance we discover that the metropolitan district in its sections most favorable for growth and improvement is mainly insular. Neither one of the three islands that contain nearly all or ninety per cent. of the naturally navigable water front of the district can be reached from the mainland except by structural agencies of either an engineering or nautical description; and we discover, also, that, down nearly to date, nautical agencies only have been brought into service. We see further that some of these agencies are of the most rudimentary character. True, little fault is to be found with the ferries. The boats are generally spacious, often elegant in design and decoration, and move with a frequency and despatch which, considering the directness of their lines of transit, leave little to be desired, if it does not even place them beyond rivalry on every reasonably fair day of the year. But the ferries are agencies only for the transportation of passengers and local freight, and they fail, therefore, of serving the chief needs of a great commercial and industrial center, operating over a field of continental magnitude. It is in the means for handling a long distance freight traffic that New York is most fatally defective; and as we see the ungainly scows that are used upon the harbor for transporting sections of railway trains between widely separated piers, called by courtesy floats, we cannot help wondering at the seeming want of enterprise which has so long rendered such exhibitions possible.

But we must not limit our observation to the harbor alone if we wish to comprehend all the disabilities of New York as a commercial entrepot. The surface where we will see least evidence of any capacity for engineering will be found upon the land. We shall discover it in the street plan of the city of New York itself, in the location of the warehouses, and in the consequent avalanche of trucks that distinguishes the city beyond any other city in the world, and without which it would be impossible to move any part of the large traffic which tradition rather than intelligent policy still enables it to retain. More than 30,000 trucks are needed to carry on the commerce of New York, a number which makes the truck driver the leading industrial worker of the city, almost rivaling the common laborer in his numerical strength, and standing as the representative of more than $25,000,000 of capital in vehicles and horses. But the wasted capital that he represents is not the worst offense that can be laid to his charge. He is insatiable in his demands, and imposes a tax on the commerce of the port approximating $50,000,000 annually.

It will be necessary to revive here a subject introduced a year ago in the pages of this Magazine when the articles entitled "New York's Commercial Blight" were published, and recall what was then said in relation to the political complications that have long involved the water front of Manhattan Island. Through an act of official robbery, dating back about two centuries, New York has inherited a water front system unparalleled elsewhere on the face of the globe, at any geographical point of its surface or at any period of time; and this system has proved to be as injurious as it is unconstitutional and absurd. The municipal ownership of the submerged lands around Manhattan Island, though it was not necessarily productive of all the damaging sequences that have followed, has unquestionably given to the city those broad plazas along the water front which have usurped the ground demanded for storage warehouses, and driven all warehouses, whether storage or wholesale, either to other parts of the metropolitan district or to the interior. Whatever other incidental mischief it may have caused, this piece of Bellamyism was certainly the cause of the exterior streets, and of the plague of trucks which have descended upon the city like an invading force of Kansas grasshoppers.

But now attention must be directed more exclusively to the remedy for these various imperfections. For correcting the insular disabilities of the water front the tunnel or bridge will suggest themselves to the civil engineer, according to his preferences, as the only alternatives; and the financial promoter, though necessarily conceded to be a man of infinite invention when judged by the schemes which he deliberately conceives and sometimes organizes for the benefit of the city, both below and above ground, can hardly be expected to find anything better. He will perforce be compelled to accept either the tunnel or the bridge ; but there is a choice between the two, and it will be well to devote the remainder of this article to a consideration of this phase of the subject. Which will make the best terminal improvement for the metropolitan district, and especially for New York ?

The writer may as well confess in the beginning that he is prejudiced in favor of the tunnel. But his prejudices are a result of many years careful study of the subject, and are founded on what he conceives to be good and substantial reasons. Before proceeding to their statement, however, he must be permitted to file a caveat. He has no prepossessions in favor of any of those extravagant tunnel schemes, sometimes advocated and even organized, which propose descending into the bowels of the earth and creating a subterranean city communicating between its parts through many miles of subterranean avenues. The surface of the earth was made for man ; and, except for extraordinary occasions, it will be time enough to go under ground when we are buried. But the tunnel, restricted in length to the distance necessary for maintaining communication between points separated by channels, and not made so deep at the terminals as to be difficult of access, seems to lead most directly and economically in the true way,—the only way, indeed, that promises the final removal of perhaps all the water front disabilities that afflict New York.

The advantages of the tunnel are many and various. In the first place but little more than a total length of two miles and a half under water, the only place where the tunnel builder is likely to meet costly obstructions, would be needed to bring all sections of the water front within reach of the trains. Doubtless there would be advantages in having a tunnel for every railway, and it is pretty certain that all the railways will provide themselves with tunnels for their own exclusive use when they find that the metropolitan district will no longer be satisfied with the present disconnected and extravagant service ; but in the beginning the completion of the Hudson-river tunnel, already about three-fourths through, and the construction of two similar works for the benefit of the Long Island water front, one under the channel below Bay Ridge, and the other under the East river at the point of its opening out into Flushing Bay and Long Island Sound, will supply all the accommodation needed.* The enterprise of Erastus Wiman in grappling with New Jersey and tying it to Staten Island at Elizabeth has already furnished the link that will render the two last named improvements available; and a water front railway, both surface and elevated, through the warehouse district of Brooklyn and along the entire shore of the East river, will complete a connection that will be of incalculable benefit not only to the traffic of the port but of all New England and the entire Union.

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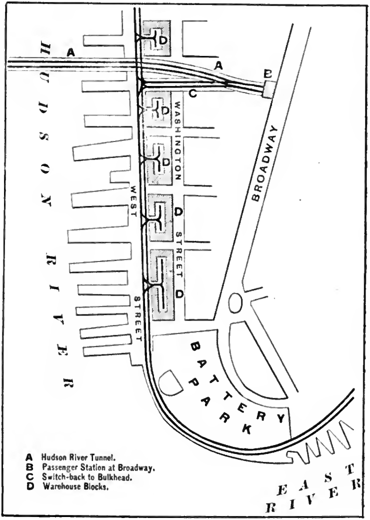
* See the map accompanying this paper.

A single glance at the map, and especially at a map large enough to expose the fact that Boston, Brooklyn, Philadelphia, Baltimore, and Washington are almost exactly on an air line, should show the superiority of this system for Long Island. It would be a connecting system in its broader features. It would be terminal only in its relations to the harbor; and it offers to Long Island the only free and unobstructed route to the mainland that can lift it above the condition of vassalage to New York which it has heretofore held. But it is New York itself, after all, that is most in need of enfranchisement; and it will be easy to show why it will derive a greater benefit from tunnels than any of its municipal neighbors. Geographically, the city is a wedge driven into the heart of the metropolitan district; and its lead is threatened only because it is blindly banishing or pusillanimously surrendering its traffic.

We must not for a moment lose sight of the fact that the curse of New York is its inflated truck service. All its warehouses and factories not driven to Brooklyn or Jersey have been scattered throughout the city by the truck service, and it has prevented their concentration along and near the water front where they belong. It is the cause, also, of those filthy, indescribable streets that have led to so much public criticism, and of that general appearance of dilapidation and decay for which many of the sections most available for improvement are conspicuous. It offers, moreover, an explanation of the fact that it often costs more money to handle merchandise in the port of New York than it costs to transport it from New York to Chicago. It is then, of course, the first disability to be removed. But could it be removed by the construction of a bridge across the North river? Would it not rather be extended and made to cover the whole city where now it is concentrated chiefly in certain unhappy districts, and localized?

Observe, first, how quietly the tunnel will come to New York, and how little its operations will disturb the city. Suppose the Hudson-river tunnel to be completed. There will be a passenger station, say at Broadway or wherever the engineers think it can be most economically and conveniently maintained. But there will be no blockade of trains. The cars will remain invisibly below the surface where only the electric light will penetrate, and as to the freight trains, they will be even less obtrusive than the pas-



SECTION OF LOWER NEW YORK CITY.

Showing proper terminals and warehousing arrangements.

senger trains. When half way up the grade to the passenger station, they may be led quietly back to the bulkhead by a switchback, as shown in our second diagram, and from thence, on surface railway tracks, they can distribute themselves along the waterfront to any part of Manhattan Island. For the receipt or delivery of merchandise, the cars can even enter the areas of all the water front blocks without intruding upon any street or public place in the city. Can anything more convenient be conceived? It should readily be seen that such an arrangement would draw all the heavy traffic of the city irresistibly to the water-front, the wholesale merchants seeking the first blocks from the river, and the manufacturers crowding as closely as possible into the same neighborhood. The arrangement would represent the perfection of forwarding machinery; and all the trucks engaged in anything but local service, a very limited service, would disappear from the streets.

But over against this picture, which is truthfully drawn, place a bridge across the Hudson, and observe the difference. In the very heart of New York, which would offer about the nearest point where such a flying structure could reach the ground, we see a huge freight station where all the traffic of the city, including possibly its coal traffic, would be expected to concentrate. But the warehouses and factories, where are they? Dispersed everywhere, as now, but, still more broadly dispersed, they would only create the necessity for longer truck hauls and more trucks. The immediate vicinity of the station would offer a surface too restricted for more than a small part of the total traffic, and no attempt at concentration would be made. Manhattan Island would soon become a place unfit for residence. Yet just those districts of the city which are suitable for commercial operations would still remain neglected, and be tenanted only for the filthiest traffic purposes as they are to-day.

On the side of economy, too, the argument is altogether in favor of the tunnel. An actual expenditure of little more than $20,000,000 would place every inch of the water front in the metropolitan district in direct connection with the railways. The interest on this sum, to be drawn from the traffic, would be $1,200,000 annually. But the cost of a bridge which would serve Manhattan Island alone, when estimated with the cost of material, labor, property purchased, and damages combined, would not be less than $100,000,000, a cost that would demand an annual payment of $6,000,000 in interest. The traffic would not meet such a charge without bearing a much heavier tax than is imposed by the float and ferry service, which, though costing a great deal, does not cost more than the interest on $35,000,000. Under the operations of a bridge service, too, another $50,000,000 annnally wonld soon have to go to the support of truckmen.

These are the chief reasons for preferring the tunnel to the bridge. They conld be strengthened greatly by amplification, and there are still other reasons of minor weight that might be thrown into the balance. It could be said, for example, that the suspension bridge, which is an inverted arch in form, is an unsuitable object for urban decoration, and that the cantilever bridge is still more objectionable from the esthetic point of view. But the argnments drawn from economy and the necessity of relieving the streets of New York are so heavily on the side of the tunnel that any further reasoning in its behalf seems like a waste of time.

LABOR LEGISLATION IN ENGLAND.

By R. S. Viktorov.

"LABOR legislation" is notoriously a perpetual topic of all contemporary law-making bodies. Everywhere labor loudly demands "protection" against the encroachments of the employers; and politicians, making a virtue of necessity, grant more and more of the demands. A bold minority of the workmen go to the length of agitating for the total suppression of private, competitive enterprise and the assumption of all industrial functions by the State. Few practical and active men of affairs sympathize with this utterly impracticable revolutionary plan, but there is as yet scarcely any recognition of the fact that the same vicious principle underlies most of the less radical proposals advanced in the interests of "labor," and hence even among business men of experience the opposition to paternal legislation is but feeble. In truth, labor's implicit trust in legislation is no anomaly. Most of us are addicted to the habit of appealing to government for aid and salvation. The feeling is widespread that "the law" can and should eliminate all existing evils and rectify all surviving wrongs. It is to politicians that manufacturers look for profits, farmers for low interest and high prices, workmen for good wages and short hours. This universal faith in the efficacy of legislation persists in spite of overwhelming adverse evidence. The absolute failure of one law does not prevent us from clamoring for another of the same kind; the mischief following one legislative excursion into the business sphere does not serve as a warning against inviting another.

Look at recent federal legislation in the "people's interest" in the United States. The present financial crisis is generally attributed to the Sherman silver law,—a law that was passed to secure the benefits of an abundant currency. Will the pernicious consequences of this act teach the lesson of less government-tampering with currency and more financial freedom? Hardly. Or take the tariff. Whether we are theoretically protectionists or free-traders, the absurdity of a large class of business men anxiously watching every move of a lot of politicians in Congress must be manifest to all. Frequent changes breed confusion, uncertainty, distrust, while business requires stability and confidence above all things. As long, however, as the tariff remains "in politics," no permanent condition is possible. The interstate commerce law is another abortive effort to check certain objectionable practices that competition alone is competent to deal with. The "protective" features of the law are successfully evaded, while new evils are called into being by it that are offset by no advantage whatever. And where are the great results of that other popular measure, the anti-trust law? The few attempts at its enforcement have only furnished amusement and political capital.

The important consideration is that every restriction tends to cripple industry and hurt both employers and employed. Blind interference with the laws of industrial development, attempts to accomplish results which in the nature of things cannot be arbitrarily and summarily accomplished, retard the increase of wealth and the spontaneous adjustment of the relations between the coöperating forces in production. Industry needs freedom, opportunity. Business men need to learn the lesson that industrial freedom is the first condition of prosperity and stability, and that politics is fatal to business.

The whole history of English labor legislation—the parent of all paternal and socialist proposals—enforces the truth that the true interests of labor cannot be promoted by political measures. The record is one of failures, abortions, farcical results, and disappointments. No proper history of the rise and growth of the factory system and the concomitant legislation has yet been written, but the facts afforded by the historians of this system are instructive enough to be reviewed here.

The first English factory (in the modern sense) was the celebrated silk "throwing mill" erected in Derbyshire, in 1719, by Sir Thomas Lombe. It is certain, however, that factories of a primitive kind were in existence before that date. In 1340 one of the chief promoters of cloth making in Bristol was ordered by a local court to pay a fine "for having caused various machines for weaving and making woollen cloths to be set up in his houses, and for having hired weavers and other workmen for this purpose." Lombe's patent for the machinery expired in 1732, and the "industrial revolution" was started upon its way. In 1832 the change in industrial method had spread so wonderfully that we find parliament and the country debating the first comprehensive scheme of legislation devised to modify some of the results of the new system.

There was violent opposition to the early factories on the part of the working people, and the popular literature of the day gives expression to the feelings of the dissatisfied operators. "When the first factories were erected," says "Alfred," the historian of the factory movement from 1802 to 1847, "it was soon discovered that there was in the minds of the parents a strong repugnance to the employment thus provided for their children," and "for a long period it was by the working people themselves considered to be disgraceful for any father who allowed his child to enter the factory." As early as 1779 a spinning mill of Arkwright's was wrecked. Somewhat later Peel's printing works were gutted and the machinery destroyed. When the first steam-engine for spinning was erected by Mr. Hall, he was obliged to convert his mill into a garrison and keep the gates locked both by day and night. These are samples of what occurred in Lancashire, and similar scenes were enacted in Yorkshire and in the Midland counties. Factories were destroyed, manufacturers attacked, and one manufacturer was shot near his own home. As late as 1835 opposition was encountered, when steam was first applied to ribbon-weaving. The interesting fact may be recorded that in the case just mentioned the very remarkable experiment was tried, in the hope of conciliating the workmen and combining the advantages of the factory with those of domestic industry, of having a central engine to supply power to a number of cottages grouped round. The experiment naturally failed.

Froude quotes the curious statute passed in the reign of Philip and Mary which was directed against factories. The statute is called "An Act Touching Weavers," and runs thus: "Forasmuch as the weavers of this realm have . . . complained that the rich and wealthy clothiers do in many ways oppress them, some by setting up and keeping in their houses divers looms, and keeping and maintaining them by journeymen and persons unskilful, to the decay of a great number of artificers which were brought up in the said service of weaving, with their families and their households, some by engrossing of looms into their hands and possession and letting them out at such unreasonable rents as the poor are not able to maintain themselves; . . . some also by giving much less wages and hire for weaving and workmanship than in times past they did, whereby they are enforced utterly to forsake their art and occupation; . . . it is, therefore, for remedy of the premises and for the avoiding of a great number of inconveniences which may grow if in time it be not foreseen, ordained and enacted by author-

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ity of this present Parliament that no person using the feat or mystery of cloth-making and dwelling out of a city, borough, market-town or incorporate town, shall keep or retain or have in his or their houses or possession any more than one woollen loom at a time, nor shall by any means, directly or indirectly, receive or take any manner of profit, gain, or commodity, by letting or setting any loom or any house wherein any loom is or shall be used or occupied, which shall be together by him set or let," etc. A provision follows limiting weavers living in towns to two looms. The intention of course was to prevent the cloth manufacture from falling into the hands of large capitalists, and to enable workmen to earn their living in their own separate homes.

It is instructive to recall this pathetic preference for "home work" and bitter opposition to the factory in these days of popular and philanthropic clamor *against* home work. Labor reformers who are so anxious to force all workers into the factories are probably unaware of the attitude of the early factory workers and their champions towards the new arrangements that faced them.

Whether the anti-factories statute was formally repealed or simply disregarded and consigned to oblivion is not stated by the historians. It was never vigorously enforced, though there is no doubt that the legislation which was directed against labor was faithfully carried out. It was not till 1795 that a workman could legally travel in search of employment out of his own parish; it was not until 1812 that the power of the magistrates compulsorily to fix the laborer's wages was withdrawn; and the famous statute of apprentices was not repealed till 1814.

In 1796 the first protest against "unregulated factories" was raised by a committee called the "Manchester Board of Health," which enumerated the evils of the factory system and proposed an application for parliamentary aid to establish a system of laws for the government of cotton factories. By that time the repugnance of the operatives to factory labor had been largely overcome, and some had actually begun to live on the wages of their children. The first bill dealing with the subject of child labor was that prepared by Robert Owen and presented to members of Parliament in 1816. It forbade the employment in factories of children under ten years of age, and limited their hours of work up to eighteen years to 10½ hours a day. It further prohibited them from night work, and provided for half-an-hour's instruction daily at the expense of the employer; it was to apply to all "cotton, woollen, flax,

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and other mills, manufactories, and buildings, in which twenty or more persons shall be employed under the age of eighteen years." Sir Robert Peel at first pretended to favor the measure, but subsequently he declined to father it, and introduced, instead, a bill to apply exclusively to cotton mills, which was far less stringent in its provisions. This, however, was not the first factory bill brought before Parliament. Sir Robert Peel had already passed one important measure through that body,—the Factory Health and Morals Act of 1802. This first English factory act applied principally to *apprentices* in cotton mills, and in no wise affected *free labor*. Its principal provisions point to a time when the employers stood in a sort of paternal relation to their apprentices, and indicate that the new industrial system had not yet emerged from that phase when mills were built in unfrequented places and supplied with apprenticed workers from a distance. The apprentices' hours of work were not to exceed twelve a day, and they were to be instructed every day, during the first four years, in reading, writing, and arithmetic, the time to be counted out of their work-hours. They were likewise to be instructed in the principles of the Christian religion, and made to comply with various religious ordinances. Other provisions relate to their food, apparel, and health.

This law, by placing apprentice labor at a disadvantage, constrained the manufacturers to abandon it. They now preferred *free* labor. This effect of the law, coupled with the adoption of a new motor, which, by removing the necessity of building factories in remote and water-abounding districts, and permitting their establishment in populous places, rendered the apprenticeship system unnecessary, was in turn the cause of the next move of the factory reformers. In 1815 Peel proposed a new measure applying to all children alike. What he proposed was that no child should be employed under the age of ten years and that the duration of children's labor should be limited to twelve hours and a half per diem, including the time for education and meals, which would leave ten hours for work proper. In presenting this bill Peel regretfully acknowledged that the inspectors appointed under his previous bill had been very remiss in the performance of their duties. But this bill met with vigorous opposition, and its author was induced to alter the form of his motion into a proposal for a committee of inquiry to ascertain the conditions of child labor and report to Parliament. This proposal was accepted, and a parliamentary inquiry—the first of its kind in English history—was authorized. The committee commenced its sittings in 1816. Its proceedings and conclusions were alike contemptible. It was in fact a complete fiasco. The value of the testimony taken by it may be judged from the fact that, whereas the average death-rate in England at that time was 1 in 50, it appeared from the "evidence" that in the cotton factories it was 1 in 445! The reformers generally exaggerated the evils of the state, while their opponents indulged in preposterous eulogies of factory labor. On the one hand, medical men and other witnesses spoke of the absolute impossibility of supporting healthy life under the circumstances that existed in the factories, while on the other tabular statements and documents signed by clergymen and magistrates were presented showing the superiority of the health and *morals* of children employed in factories over those of children employed in other trades. One witness, a surgeon, was not sure that the inhaling of dust and cotton fibre was injurious to health, suggesting that the bad effects in this case might be counteracted by "constant expectoration."

The upshot of this "investigation" was a new law, passed in 1819, applying exclusively to cotton mills. It forbade the employment of children up to nine years of age, limited the hours of work for all persons under sixteen to twelve per day, less 1½ for meals, and made some provisions for recovering time lost by defect of water. The law, however, contained no adequate provision for inspection and attendance of witnesses in cases of prosecution, and hence was easily set at nought. Several amendments of the law followed, the last being that passed in 1831, which prohibited night work in the case of persons under twenty one years of age in cotton factories.

Discouraging as these results were to the promoters of factory legislation in parliament, the operatives and the reformers outside of parliament found in them a stimulus to further agitation. Demands were boldly made for a work-day of ten and even eight hours for children. But the government had now determined to take the initiative themselves, and stave off radical legislation by moderate proposals. A motion was made on behalf of the government for the appointment of a royal commission to visit the factory districts and collect information. It was adopted, and the commission was appointed. The operatives and their friends resented the presence of the commissioners in their districts, and protested against the proceedings. They asserted that full evidence on all important points had already been collected, and that the real object of the government was to procure evidence unfavorable to further legislation. The commission, however, reported in favor of further legislation on behalf of the factory children, and in 1833 the government offered and passed the important bill commonly spoken of as Lord Althorp's Act, which has formed the basis of all subsequent legislation. The act prohibited the employment of children under nine years of age in all mills and factories except those for the manufacture of silk. It was made unlawful to employ children in any mill for a longer time than forty eight hours in one week, or nine hours in any one day. Two whole and eight half-holidays in the year were provided for, as well as daily attendance at school for at least two hours. Surgical certificates of age were required, and factory inspectors were given large powers. No person under eighteen was to be employed at night. Compulsory education was for the first time formally recognized as a function of government.

But scarcely was Lord Althorp's Act in operation when numerous and grievous imperfections in it were indignantly pointed out by the factory reformers. Several of the clauses were so drawn as to be absolutely incomprehensible, and the important item of administration was a total failure. The provisions respecting meal times were insufficient, and a wide margin was allowed in the selection of the working hours of the protected employés. A regular system, known as the Relay System, was at once devised for defeating the intentions of the act. To keep their machines going longer than twelve hours, the manufacturers established relays, which commenced work at different times of the day; and the factory inspectors declared that so long as the employers had the power to work relays, to fix irregular meal hours, and to alter continually, at pleasure, the working time of every individual, no legal restriction of the time of labor could be enforced. The regulations respecting certificates of age did not work well. The expedients for gauging the ages of children applying for work were all unreliable, and parents obtained certificates for immature children by substituting older ones for them. When inspectors visited the works, the doubtful cases were hidden under large baskets or otherwise concealed; or their shoes and clothing were stuffed to make them appear stouter and taller. There were other defects in the law. The time within which an information for an infringement of the law might be laid was only fourteen days. Manufacturers were not prohibited from sitting in judgment on factory cases. The overworking of any number of children simultaneously by an employer was construed as one offense and punished accordingly. Hence it was more profitable to break the law than to obey it.

Under these circumstances the agitation was renewed, and several unsuccessful attempts were made to amend the bill which had proved so ineffective. In 1840 a resolution was passed providing for a children's employment commission. In 1843 the commission made its report, urgently favoring legislation with reference to certain trades and manufactures. The only result, however, was an act applying to print works, which pleased nobody.

A new factory bill was passed in 1844. This bill embraced precautions against the devices which had defeated the previous measure, and contained some novel and striking features. It was now proposed to extend the protection of the law to adult women, and machinery and mill gearing were to be fenced. The hours of work for children were reduced to six-and-a-half per day, to be taken either in the morning or afternoon. In 1847 the ten hours act was passed, which limited the hours of labor for women and young persons to ten hours a day and fifty-eight a week. But the relay system was again introduced, and it was impossible for the inspectors to enforce the law, especially since the courts had declared the relay system legal. To surmount these difficulties a compromise bill was passed which established a different limit to the working-day,—namely, from six A. M. to six P. M. in summer, and from seven A. M to seven P. M. in winter, with one and a half hours for meals, and till two P. M. on Saturday. This statute brought the ten hours dispute to a close, and remained in force for fourteen years. In 1860 bills were passed regulating bleaching and dyeing industries, and soon afterward legislation was applied to lace work and bakeries.

In 1862 a second children's employment commission came into existence, which "nearly exhausted its subject," and issued numerous reports. The first important result of its labors was the new factory act of 1864, in which the previous legal conception of a factory, as a place where only textile fabrics are produced and mechanical power employed, was formally abandoned. The new act applied to four kinds of manufacture not textile, and to two kinds of "employment." The agreement was that in those particular industries and employments—the manufacture of earthenware, lucifer matches, cartridges, etc., and the employments of

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paper staining and fustian cutting—hardships prevailed, and therefore required to be regulated and looked after. Naturally this argument justified interference with numerous other occupations, and in 1867 the factory acts extension bill was passed, whose provisions applied not merely to factories in the old sense, but to any premises in which fifty or more persons were employed in any manual labor incidental to the making of any article. The transformation was almost complete, and it only remained to add places where less than fifty persons were at work to cover every material industry.

And this was actually undertaken within the same year by the Workshop Regulation act. A workshop was defined to mean any place or room in which any handicraft is carried on by any young person, woman, or child under the direction of another. The act differed little from the factory acts. At first the local authorities were charged with the supervision of the workshops ; but their failure to perform the new duties subsequently led to the handing over of the act to the factory inspectors for enforcement.

In 1874 an act was passed which amended the factory laws in certain particulars. Labor in textile factories was reduced by half-an-hour a day, the minimum age for children was raised to ten, and it was made illegal to employ a young person under fourteen who had not passed a certain educational test.

Of course these acts did not close the factory controversy. No sooner had they become law than new agitations sprang up on several new subjects. Shop labor, wandering occupations, even domestic labor, began to clamor for protection. At the same time the laws relating to factories and workshops, and the practices and judicial decisions in regard to the relation between them, had reached an intolerable pitch of confusion. To consider the new claims and reduce the conflicting and contradictory statutes to order a royal commission was appointed in 1875. The commission was to consider the consolidation and amendment of existing laws, and decide whether any of their provisions might be properly extended to other trades and occupations. But the commission disappointed the factory reformers by dealing almost exclusively with the first half of its task. They brought together existing laws into one statute, but recommended no new legislation of consequence. They excited indignation by announcing their purpose to be the relief of minor industries from the pressure of legislation and the securing of more independence to adult labor.

The factory and workshop consolidation act of 1878 which was the outcome of the commission's labors is the one still in force. It deals with five classes of works,—textile factories, non-textile factories, workshops, workshops in which only adults are employed, and domestic workshops. Certain industries—straw-plaiting, pillow-lace making, and glove-making—are left free, and the exemption extends to any handicraft exercised in a dwelling house by a family at irregular intervals. Workshops where men only are employed are, unlike factories, always exempted. A factory, under this act, is a place in which machinery is moved by some mechanical power. The works where manual power is made use of, exclusively, are workshops.

The demand for legislation at present is precisely in those directions which the current law leaves free. The cry is now for regulation of adult labor and for interference with minor industries. Laws are demanded against "sweating," home work being regarded as the citadel of the evils summarized under that term. It is held to be imperatively needful to force all workers into the factories. Strenuous efforts are made to bring all home industries under inspection. Thus Mr. Charles Booth has been giving evidence before the English Labor Commission, and he has been suggesting ways of getting rid of the "sweating evil." A good deal might be done, he thought, by a " sufficiently wide extension of the Factory and Workshops Act." He favored a provision that home workshops should be registered and made subject to inspection and supervision. He would define a workshop as any room or place where any person joined another person in manufacturing, and that *would include a man and his wife*, while two men working in partnership would be considered as employing one another. The industries which would be most affected by this legislation would be tailoring, boot-making, cabinet making, and upholstery, with seamstresses' work of all kinds. The larger number of persons employed in home workshops are women, but Mr. Booth thought that it would be a desirable thing to see home work superseded by work in factories to a very considerable extent, though not to the extent of driving it out altogether. There were thousands of cases, according to Mr. Booth, in which registration and inspection would at once begin to apply, where the rooms in which two or three persons worked were used also as living rooms and sleeping apartments.

A word may now be said on the subject of the effects of factory legislation. All the English economists were opposed to the sweeping act of 1844, and warned parliament that its passage would surely cause diminution of production, rise in cost of production, fall in rate of wages and profits, rise in prices, and loss of foreign trade. It is true that hardly any economists of to-day would wish to see that act repealed. The results they feared and expected nowhere came to pass. Instead of dwindling, the English textile industries developed enormously during the years 1850–1863, and English industry flourished during the twenty years immediately succeeding the introduction of the factory acts. But no economist claims that this prosperity is *due* to the factory legislation. On the other hand, there are economists who trace certain evils to the operation of the factory laws. The sweating system has for a chief cause this labor legislation. As one writer says: "On the whole, factory legislation tends to press heavily on the very weakest class of workers. Their last asylum is some hitherto unregulated branch of domestic industry. Such a refuge, for instance, has been the wearing apparel trade." Factory legislation has also injured the weaker elements of the capitalist class, and everything that hurts the small business man hurts the workman. During the decade 1853–63 no less than three hundred cottage factories were shut up. The struggle between the cottage factories and the factory system proper naturally ended in the complete ruin of the smaller works. This concentration of industry was unquestionably accelerated by factory legislation.

The probability is that the improvements in the condition of the operatives would have gradually taken place even if parliament had not interfered at all. It is easy to mistake coincident circumstances for cause and effect, and those who claim that factory legislation has been an unmixed blessing fall into this error.

ARCHITECTURE AT THE WORLD'S FAIR.

By Barr Ferree.

WHATEVER may be the final result of the Fair, however deeply it may impress itself and its lessons upon the people of America, its architectural teachings will be long remembered. At no time in our history has architecture as a fine art so vividly impressed itself upon Americans, and it would almost seem, so great has been the enthusiasm raised by the chief buildings of the Fair, that an architectural renaissance—a revival of the art of building in its truest sense—was about to take place among us. In a certain sense nothing could be better than the widespread discussion the buildings have caused. Architecture has not been a topic to be talked of in the newspapers or even, more's the pity, discussed among educated folk; but the newspapers and every intelligent person have had a great deal to say about these particular buildings, and it may safely be assumed that architecture, having at last made its way into the channels of popular thought and discussion, may now be accepted as one of the great topics of the day. If it were possible to assume that this will be the only result of the Fair,—which of course it will not,—it will accomplish a great and enduring work. And this being so, perhaps it may scarce be seemly to raise a voice of protest against the all but universal chorus of praise now being sung on behalf of the Fair buildings.

Architecture at the World's Columbian Exposition falls naturally under two heads: the buildings and the exhibits. It is with the former that we shall be chiefly concerned, but it is well, first of all, to take a brief glance at the place architecture holds among the exhibits. And one no sooner settles down to study architecture *at* the Fair—a very different thing from the architecture *of* the Fair—than he discovers that the greatest international exhibition, architecturally speaking, the world has seen, the most elaborate group of structures ever erected for such a purpose, the most praised and admired architectural product of our country—perhaps of our time—house the most despicable and absurd architectural collection that it is possible to imagine. A great international exhibition that has provided costly palaces for the display of objects relating to transportation, fisheries, horticulture, leather, forestry, and sundry less important branches of industry, has no space for architecture itself, save a few handfuls of drawings in the Art Palace,—and the American drawings were not even catalogued in the first editions of the official catalogue,—some scattered and grotesquely inadequate collections of stones in the Mines and Mining building, about which no information save their names and localities is forthcoming, a few electrical devices in the Electricity building, a small collection in the Transportation building, and some miscellaneous collections, scattered apparently as widely as possible, and arranged without the slighest notion of presenting our great art in an integral form, in the Manufactures and Liberal Arts building. This heterogeneous display, divided among a half-dozen buildings, constitutes, with the collection of woods in the Forestry building, and a display of sanitary apparatus in the Anthropological building,—the last of which was not thrown open to the public until the end of June,—all the World's Columbian Exposition has to show for architecture.

One positively runs short of decent adjectives in thinking of such a state of things. Never was a greater opportunity more thoroughly wasted; never could an organizing mind have produced better results with materials that might readily have been obtained. And the contempt which has been put upon the building art at the Fair is the more astonishing since its architecture is one of its chief points. The fact that the exhibition has been planned and carried out on a magnificence of scale and elaborateness of execution that leaves little to be desired, and further that it is, itself, an excellent object-lesson in practical architecture, renders it only the more remarkable that the men who planned it, who carried it out and made it the thing of wonder and of beauty that it is, should so far have neglected their own art as to omit it as a subject to be properly, suitably, and amply illustrated from the scope of the exhibition. Never was greater injustice done the noblest of the arts, never did the architects of any country or of any city—for the blame must rest largely upon the architects of Chicago—so stultify themselves or express greater contempt of an art, which, if it is not an art to them, a thing to instruct people in, is at least a source of revenue and a means to support life.

It is easier to find fault than to accomplish work, but it is not too much to say that architecture should have had a building of its own. Here would have been gathered, not only the architectural drawings which are now housed in the Fine Arts Palace, but elaborate exhibits of constructive materials and methods,—neither of which are sufficiently well illustrated in the exhibition,—apparatus used in making special classes of buildings useful and inhabitable, sanitary apparatus of all sorts, electrical and mechanical devices employed in the construction of buildings and in daily life, heating-apparatus, and full lines of everything coming under the architect's province. More than this, models of structures might have been shown, illustrative of various classes of buildings. The economic applications and lessons of architecture could have been illustrated, as well as historical forms and exhibits of an historical nature. Finally, to bring our very rough and imperfect classification to an end, the fine and decorative arts bordering upon architecture and actively connected with it might have been included in the same great building. Then, when careful and competent minds had filled in the vacancies in this rude plan, a collection of unrivaled interest might have been shown, and inquiring people taught that architecture is not only the greatest of the arts but the most difficult, that the work of an architect does not consist in sitting down in his drafting-room and composing pretty pictures for the pleasing of the eye, but in mastering a thousand different matters, solving a thousand different problems, looking at things in a thousand different ways in order to produce a structure which shall be not only beautiful but useful.

But we have none of this. One can gain a better insight into the progress and work of current American architecture by examining the advertising pages of any of our architectural periodicals than by a visit to the World's Columbian Exposition.

But though the architectural exhibits quite fail to indicate or so much as hint at the real progress American architecture is making every day ; though one can learn absolutely nothing of constructive architecture at the Fair save by studying the internal construction of the buildings,—the latter go a considerable way in making up the deficiency. Instead of supplementing the architectural display, in affording practical examples of certain phases of architecture, they constitute the most important part of what the Fair has to show for the art. And the severest critic must admit that the effect of the buildings and grounds is very fine, that the result is vastly superior to what the most ardent praiser of the Fair led one to expect, and that all hands may be well satisfied with what they have accomplished. In a certain sense this is true; in more ways than one the visitor is dazzled by the grandeur of the scene now on view in Jackson Park for the ridiculously small sum of fifty cents; and further, if one is so fortunate as to witness a night illumination, and above all a display of fireworks in the Court of Honor, words utterly fail to express the sensations created. One forgets then the faults of the buildings, forgets the exaggerations of the faddists, forgets that the reality, as seen in daylight, has many blemishes which more careful study would have eliminated.

It is not necessary here to review the general plan and disposition of the buildings. The illustrated newspaper press has long since made them familiar throughout the civilized world; a few notes on their architecture may, therefore, be presented without the formality of beginning at the beginning and going over ground that has already been thoroughly traversed.

One has not been very long at the Fair before beginning to wish that there was not so much landscape gardening. Now this is one of the strong features of the Exposition, and the marvelous skill with which the sand-banks on Lake Michigan have been transformed into a park of ravishing beauty has been the theme of many a rapture by many an observer. Beautiful as it is,—and it must not be inferred that I am questioning that element,—it is nevertheless a fact that the landscape gardening and arrangement of the grounds is a distinct drawback to their enjoyment. An international exhibition is a thing of joy, a festival, a jubilee. One does not expect that its inspection will be a laborious task or an undertaking of such magnitude that only the most robust dare attempt it. Yet the distances in the grounds are enormous; even the buildings around the lagoon forming the Court of Honor are difficult of access unless one is satisfied to follow them in the order in which they are built and never deviate from the program. A remedy would doubtless be swift and cheap means of conveyance from one building to another, and it is possible that some scheme to accomplish this may be in force before these words are printed. But it is one of those things which a landscape gardener, filled with zeal for his art, and especially when given such a great opportunity as Jackson Park afforded, would overlook. Beautiful as the grounds are, they are utter failures when judged by the standard of utility. If perchance you don't believe it, go and try it, and I will warrant that in a day or so you will appreciate the point.

To a very great extent architectural interest centers in the Court

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of Honor. Not that the finest buildings on the grounds are located there, but the most important ones—except the Fine Arts Palace—face it, and it has been made the central point for architectural display. Yet the finest things in the Court are not the buildings, but the sculptures which decorate it. Save those of Agriculture and Machinery, none of the buildings are in any way remarkable. The Administration building is a serious attempt to surround a dome with utilitarian offices, but the dome loses very much in being octagonal, instead of circular; its perspective is constantly bad and distorted in consequence, while it is further injured by lack of a finish; a lantern or even a statue would have helped it very materially. Internally the effect is disappointing. The wall decorations are insignificant, much of the coloring of too light a shade, and the fresco which is intended to decorate the ceiling almost wholly out of sight.

Machinery Hall is one of the few pleasant disappointments of the Fair. No drawing does this building justice, one shown by the architects in the Fine Arts Palace being, if anything, especially bad. Seen in the reality, it shows itself to have great dignity and beauty of design. The lateral colonnades are very well done, though the coloring of the walls behind them is lighter in tint than it need have been. The towers and domes are vastly more successful and pleasing in the structure than in the drawings. The architectural decoration of these parts is rich and effective, and is in striking contrast with the sculptural decoration of its near neighbor, the Agriculture building. The towers and the building in general are, perhaps, rather too plentifully decorated with figures of angels, but they do not detract from the generally satisfactory result. The porches are the most unfortunate part of the design. These—I refer to the rectangular porch facing the Agriculture building, and the semi circular porch on the long façade—do not grow out of the building, but are "stuck on," as it were. They are ornamental appendages, very good in themselves, but without organic connection with the structure they decorate.

More than any other building on the ground, the Agriculture building impresses one by its sculpture. Architecturally the building is very successful, and the design lends itself to a rich sculptural ornamentation that has been applied wherever available. And this sculpture is not architectural decoration, but groups that, most of them, would look as well off the building as on it.

In this respect the building stands alone among those on the grounds, for here the sculptor has been given his greatest freedom, and here he has most amply availed himself of his opportunities. That these have been too many can scarcely be questioned. The piers which break the arcades of the façades, for example, and each of which carries a sculptured group, seem rather to be designed for that purpose, for they are clearly not needed for structural reasons. The walls of the porticoes of the building have been treated in color in a rich, brilliant, and effective manner, so that in sculpture and painting the Agriculture building stands alone among the buildings on the Court of Honor. It is a most interesting experiment in decorative architecture, if such a term may properly express the coördination of architecture, painting, and sculpture in an external effect.

The Manufactures building—which from its vast size must be, by the usual American standard, the best building on the grounds, if not the best in the world—is one of the least successful. Neither painting nor sculpture appears in its exterior, save for a series of eagles on the central pavilions. It was a wise restriction, and one of great benefit to its opposite neighbors, Agricultural and Machinery halls. Great though the building is in size, it does not show it. The roof is much too high, and, though the enormous arches are wonderful pieces of construction, there was no reason at all for making them as high as they are. Nothing within the structure calls for such great height, while the design is one that dwarfs the building exteriorly and helps to hide its true proportions. The design of the exterior is ruined by attempting to carry two series of arches one over the other. Nothing is so likely to result in failure as this, and the Manufactures building is no exception to the rule. The design, as doubtless will be remembered, consists of a series of segmental arches, carrying an arcade of round arches. The juxtaposition of the two forms of arch is very bad. Had a straight line been used for the lower story, with an ornamental frieze to break the monotony of the wall surface, leaving the upper arcade as the single arch in the façades, the result would have been much more successful. The really remarkable feature of this building is its construction, of which, unfortunately, few save architects and engineers will take notice. As it is, a vast number of people will go away from Chicago this summer convinced that the Manufactures building is the best and most successful thing on the grounds, and for no other reason than that it is the biggest. Is the best-looking man he with the largest mouth? What has size to do with beauty or in determining the relative excellence of a piece of architecture?

Of the Mines and Mining and Electricity buildings, the two remaining structures upon the Court, nothing need be said save that neither does justice to its authors. Both are comparatively small buildings, and hence are necessarily without the interest attaching to the larger ones. Nor is it needful to enlarge upon those abominations, the Government building and the Illinois State building. Yet these should not be hastily condemned, since in showing the natural outcome of officialism in architecture they are really the most useful structures upon the grounds. The strange thing about these buildings is, not that they were erected, but that it was within the capacity of human brains to conceive of anything so dreadful. The rotunda of the Government building is a miracle of the absurd in architecture, and that of the Illinois State building a good second to it. The Fisheries building must be dismissed in a very few words. Designed in a Romanesque style, the architect has departed from the traditions of the Court of Honor. Judged by the standard of utility, his building cannot be pronounced a success. There is no reason in the arcades which connect his wings with the main edifice, save the production of an awkward plan that is both confusing and wearisome to the visitor. The most characteristic feature of this structure is the carved decoration of all sorts and conditions of fish and sea-beast, which have been pressed into service for architectural purpose. As the ordinary elements of architectural ornament, those drawn from geometrical forms and from vegetable life, have been the results of study and work for some thousands of years, it is not to be supposed that a single architect, and a busy one at that, can successfully transform fish life into forms equally successful in a single venture.

Then comes the Palace of the Fine Arts. If one is to believe the guide-books, no voice has yet been raised in disparagement of this "crowning glory" of the exhibition. An eminent faddist, hailing from the metropolis, tells an awe stricken world that, "if the Greeks had built a dome, they would have built it just as it has been built in this building." An eminent architect, himself the author of one of the most successful buildings on the grounds, tells us "it is the greatest thing since Athens." There is no limit, as may be seen from these quotations, to the praise uttered in be-

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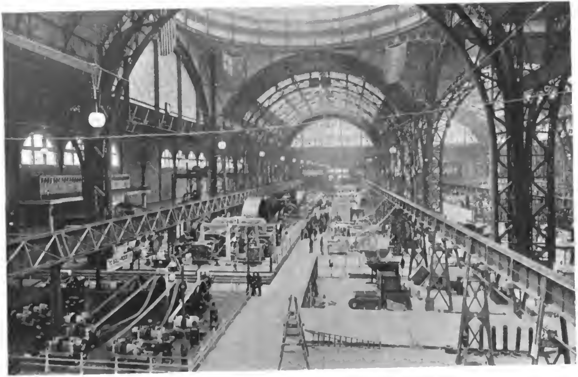
half of the design of this building. The design is good, but it by no means warrants the extravagant praise gushed out for it. Its chief strength lies in its quietness, in the subdued manner in which the parts have been treated, and the harmony with which they have been brought together. The dome, at which both criticism and the building culminate, is marred by its base, consisting of two semi-circular rings, one of less diameter than the other, and which unpleasantly suggest two low bandboxes placed one on top of the other, and an inverted soup-plate over all. The annexes attached to the building, and which are really an integral part of it, stretch away in the rear in an alarming fashion and detract very much from the design. It is an earnest effort to produce a purely Greek building, but it is very far from warranting the absurd praise that has been given to it.

Of the great buildings upon the grounds there remains only to notice the Transportation building. Somewhat removed from the other chief buildings, it stands alone both in location and in art. It is not too much to say that, without any exception whatever, this is the most ambitious and successful example of polychromatic architecture in America. For in this building, unlike any of the others, the color decoration has been carried out on a most elaborate scale, and, while it is decorated with some pieces of sculpture, and its great Golden Doorway is itself a masterpiece of the sculptor's art, it is the color decoration that gives it its character and its beauty, lifts it out of the rut of classicism, into which the other Fair buildings drift, and makes it the most remarkable and interesting structure upon the grounds. No bolder scheme than this richly-colored building has been undertaken in American architecture, and the Fair teaches no more notable lesson than is impressed by this great work of art. The Golden Doorway, as perhaps need not be stated, is the central feature of the design. Here, in a series of recessed arches, the architect has woven a carved decoration, partly geometrical, partly foliated, of marvelous beauty and ingenuity. These arches are deeply recessed so as to make the door opening in the center only of sufficient size to be properly useful. A broad band of ornament entirely surrounds the central portion, thus effectively framing the main doorway. All this is in decorative relief that is strictly architectural.

But it is to the polychrome decorations of the wings of the building that the attention of the architect will be chiefly directed. The boldness of the conception startles one at first, for the idea of a building completely decorated with color is a novelty in our latitude. Yet Mr. Sullivan has shown himself a man not only of genius but of courage, and his work justifies him in its complete and rare beauty. The chief feature of the design is a very broad band of painted ornament carried around the building immediately under the molded cornice. This is a rich and beautiful conception, of complicated, yet well-arranged design, and exquisitely colored; though including a great variety of tints and tones, it is wholly harmonious. Between the windows is a series of angels with extended wings, each carrying a streamer with the name of some man great in transportation painted on it. These are exceedingly dignified, well-conceived figures, and their white robes admirably relieve the brilliant color of the frieze. The exposition contains nothing nobler, nothing more successful than this building, and there is nothing upon the Fair grounds that will more amply repay study. It is unjust to compare it with the other buildings or to place the other buildings in comparison with it. The architecture of the Court of Honor is wholly distinct in conception from the architecture of the Transportation building. The beauty of the one is not the beauty of the other, and by endeavoring to impress a single standard of measurement upon their excellences one loses the value of each. Those will profit most who, in seeing the white buildings, will forget the polychrome structure, and in viewing the latter will see only it.



A PORTION OF THE POWER PLANT, MACHINERY HALL, WORLD'S COLUMBIAN EXPOSITION.

THE ELECTRIC AND POWER PLANT AT THE WORLD'S FAIR.

By W. S. Monroe.

IN 1876 President Grant started the machinery of the Centennial Exhibition by turning a false throttle-valve, while an engineer beneath the floor admitted steam to the cylinders. In 1893 President Cleveland pressed an electric button, and by that touch alone turned the wheel of the big engine one thousand feet away, and started the pumps of the fountains one hundred feet beyond. The great triumph of the exposition of 1893 over 1876 is power which has developed in electrical science within the seventeen years. In 1876 the Corliss engine of 2000 horse-power drove all of the machinery of the Centennial Exhibition, and furnished all the power used. In 1893 the Reynolds engine of 2000 horse-power that turned to the president's touch drives two electric dynamos which form but so many units in the greatest electric plant in the world, and which employ less than 7 per cent. of the total energy of the plant. In 1876 the practical utility of electricity was confined to electric bells and annunciator calls. The telephone was an experiment, and people eagerly paid for the novelty of talking over a line from the main building to the Philadelphia city hall. The electric arc-light was a toy, the electric railway was practically unknown, and the incandescent light even more so. Electrical science was then in its infancy, and the world may look with wondering eyes upon the exhibition of the development which it has made within these few short years. The electric system for the exposition grounds and buildings at Chicago stands a climax to the thousands of electric stations which, as if by magic, have sprung up throughout the world.

The problem of the electric plant was a difficult and complex one. The continued and prolonged uncertainty as to the demands to be made upon it, the consequent frequent additions to its capacity which were necessary, and the difficulty of obtaining the proper machinery exhibits required for particular situations, rendered the plant more a growth than an organized unity from its conception. The electric plant, after much discussion, was located along the south side of Machinery hall, the engine and dynamo rooms occu-

ENGINES AND DYNAMOS IN MACHINERY HALL, WORLD'S COLUMBIAN EXPOSITION.

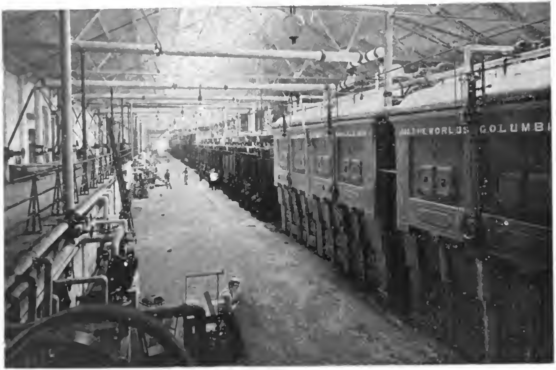
pying a space 100 feet wide and extending the full length of the main building and about 250 feet into the annex,—a total length of over 1000 feet. It was first thought that the plant would be confined to the main building, but subsequently the addition of the annex space was found indispensable. The boiler-room is an extension on the south of Machinery hall, 86 feet wide, running almost the length of the building. The addition of the boiler-house annex, which is a continuation along the hall annex, was found necessary at a later date.

The engines of the electric plant were furnished free of cost by their manufacturers as working exhibits. It was found impossible to obtain the boilers on like terms, and, after receiving several bids, contracts were made with eight companies for boilers, based on a guaranteed evaporation of water, at the rate of $5.33 per horse-power of 30 pounds of water per hour. The list of boilers, as installed, with the guaranteed water evaporation per hour, follows:

MAKERS.	Boilers.	Pounds Water.
Abendroth & Root Co.	4	45,000
Gill Water-Tube Boiler Co.	4	45,000
Hiene Safety Boiler Co.	8	112,500
National Water-Tube Boiler Co	4	45.000
Campbell & Zell Co.	9	112,500
Babcock & Wilcox Co.	10	90,000
Stirling Boiler Co.	4	54,000
Hiene Safety Boiler Co. (second contract)	4	56 200
Climax Boiler Co	3	60,000
Stirling Boiler Co. (second contract)	2	27,000
Total	52	647.200

This total of 647,200 pounds of water per hour is equal to about 20,000 commercial boiler horse-power, but, as by far the greater number of engines in the plan are compound and triple-expansion condensing engines, using only from eleven to eighteen pounds of steam per hour for each horse-power, the boilers are amply available for 50 per cent. above their commercial rating.

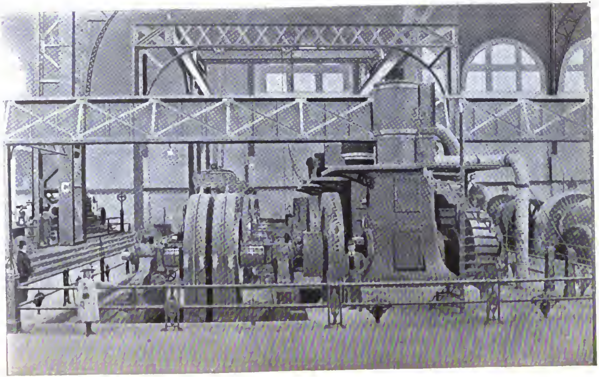
The boilers are arranged in a continuous row, fronting toward Machinery hall. They are placed in the order given above, beginning at the east end, the first seven batteries in the main room and the others in the extension. The floor of the firing-room is twenty-five feet wide and is nine feet below the main floor of the Machinery hall, a gallery twenty feet wide on a level with the latter extending out into the boiler-house, so that a view of the boilers is had from this gallery, most of which is given up to promenade, though some feed-water heaters and other apparatus are located upon it.



VIEW OF THE MAIN BOILER-ROOM, FROM THE WEST END.

The fuel used in the furnaces is natural oil exclusively. This is delivered to the grounds from the station of the Standard Oil Company at Whiting, Indiana, through a pipe-line which also supplies the Illinois Steel Company's works and other factories at South Chicago, and the Hyde Park gas works. The oil is received at the grounds in twelve storage-tanks located in underground vaults at the southeast corner of the park, 3200 feet from the boiler-house. The tanks are each eight feet in diameter and twenty-five long, and have a total capacity of 112,500 gallons. As the power plant is usually operated, the tanks contain from three to four days' supply of oil, but, when the plant is run to its maximum capacity, it will empty one tank every hour. A small pumping-station is located near the oil-vaults for the delivery of the oil to the boilers. It is first pumped into a stand-pipe thirty feet high, whence it is delivered directly to the burners through a five-inch pipe, the standpipe maintaining a uniform pressure at the boilers. The oil-pumping station is fitted with duplicate delivery-pipe, boilers, pumps, and piping, and with by-passes and cross connections and with an arrangement by which oil can be delivered from tank-cars, so that the failure of any portion cannot stop its operation. The oil-burners used under the boilers are of various makes, having been almost entirely left to the choice of the boiler contractors.

To return to the engine-room, the engines and dynamos were laid out in the space allotted as rapidly as the machinery was definitely decided upon, and as systematically as the conflicting elements of the requirements of the machinery and the constructional details of the building permitted. The dynamos were supplied under contracts with different electrical firms to furnish all apparatus and instruments needed for lighting the different portions of the grounds and buildings. The incandescent lighting for the entire park was let to the Westinghouse Electric Company, the contractor not only to furnish the apparatus, the dynamos, lamps, switchboard, etc., but to do the wiring as well. The arc lighting was divided among six firms,—the Brush Electric Company, the Fort Wayne Company, the Standard Company of Chicago, the Thomson-Houston Motor Company, the Excelsior Company of New York, and the Western Electric Company. The electric-power generators were placed with the Mather Electric, the Eddy, the C. & C. Motor Company, the Westinghouse, and the General Electric companies. The contracts for electrical apparatus were all made for a certain amount of machinery with the possible addition at contract terms



DIRECT-CONNECTED WESTINGHOUSE ENGINES AND DYNAMOS.

of a specified amount, if the exposition should find it necessary. These additions were all found ultimately to be required.

At the outset it was decided that the engines for the electric and power plant could be obtained from those offered as exhibits. The real difficulties in the way of obtaining the kind of engines adapted for the special work and certain situations were not fully apprehended, but the plan was carried out to the end.

The incandescent-lighting machinery is the largest and most prominent section of the plant. The Westinghouse company decided that all the dynamos furnished by them should be 10,000-light alternating-current machines requiring about 1000 horse-power each. Ten of these machines were at first to be furnished, but two more were afterward added. The E. P. Allis Company of Milwaukee had early promised to furnish a 2000-horse-power engine, the Buckeye Engine Company and the Fraser & Chalmers Company each 1000 horse-power. Other engines of that size were also obtained from the Atlas Engine Works and the McIntosh & Seymour Company, when the Westinghouse agreed to furnish engines direct-connected to the dynamos for the four remaining machines. The two dynamos subsequently added were also direct-coupled to Westinghouse engines.

The big Allis engine had been promised the place of greatest prominence and was located under the south one of the three domes in the center of the building. On account of the large foundation required and the necessity of keeping the fly-wheel pit above the water line, the engine was set on a platform about 2½ feet above the main-floor level. The engine is a horizontal quadruple-expansion double-crank engine; the cylinders are 26, 40, 60, and 70 inches in diameter by 72 inches length of stroke. The fly-wheel is 30 feet in diameter with 75 inches face, is built in twelve sections, and weighs eighty tons. The shaft is eighteen diameter in the bearings and twenty in the wheel. The engines drive its two Westinghouse dynamos by two belts 72 inches wide, running one over the other, the dynamos being set in tandem. The longest of the two belts is about 160 feet, and their speed is over a mile a minute. They were furnished free of cost by the Page Belting Company.

The Fraser & Chalmers engine, belted to one of the Westinghouse dynamos, was located beside the Allis on the same platform. It is a four-cylinder, triple-expansion engine, the intermediate and two low-pressure cylinders being made from the same pattern, 34 inches in diameter and 60 inches stroke. On this central platform were also placed the three small direct-connected engines and dynamos, the current from which is used to excite the fields of the big alternators, and two 15x30x16 which run two 4000-light dynamos originally put in for temporary service.

Immediately west of the platform is a "block" containing the four direct-connected Westinghouse engines and dynamos. These machines stand side by side and form a very notable exhibit. The engines are of the vertical, steeple compound type, the low-pressure cylinder being above the high-pressure and standing 16 feet high above the floor. The cylinders are 21½ and 27 inches in diameter by 22 inches length of stroke, and the shafts run 200 revolutions per minute. The block containing these engines, dynamos, and the condensers, an aggregate of 4000 horse-power, is 47 feet wide by 90 feet long, and contains as much power as the big central block, which is 135 by 90 feet. The economy of floor space in the vertical direct-connected type is noticeable.

Next west to the "four 1000 horse-power Westinghouse block" is one containing the Buckeye, Atlas, and McIntosh & Seymour engines, each belted to one of the Westinghouse dynamos. The Buckeye engine is a four-cylinder triple-expansion. The Atlas and McIntosh-Seymour are each double-tandem compounds. West of these engines are the two additional direct-connected machines which complete the incandescent plant. The Westinghouse dynamos are controlled from the largest switchboard ever constructed, which is located on an elevated platform against the wall to the south of the main block. The board is of white marble and is in two sections, the lower one controlling the dynamo leads and the exciter wires and the upper one the line mains. Nearly 250 cables run from this board.

The arc-lighting plant is very much divided, no attempt being made to keep it together, though each make of dynamos, with the engines which drive them, occupies a separate block and is a distinct station with its own switchboard and accompanying apparatus. The arc-dynamos are all 50- or 60-light machines, and, where engines of more than 200 horse-power are employed, a counter-shaft is necessarily used, being placed in the basement in all cases, the belts running back through the main floor to the machines.

There are sixteen Brush dynamos belted direct to five Ball and Wood engines at the east end of the incandescent plant, and at the opposite end is a block containing the Fort Wayne dynamos driven by five Buckeye engines of as many different types and sizes. These five engines, with the triple-expansion Buckeye, form in some ways the most complete engine exhibit in the building. Next to the Fort Wayne block is one containing twenty Standard dynamos, four of which are belted direct in two tandem pairs from a 15x14 Erie City engine, and the others are driven by countershafts from two Russell engines, one a tandem compound of 200 horse-power and one a double tandem of 600 horse-power.

The rest of the arc-lighting machinery is in the Annex. There are in one block sixteen Thomson-Houston dynamos driven by three Lane & Bodley Corliss engines,—a simple, a tandem, and a cross-compound,—and next to these ten more Thomson-Houston machines and six Excelsior machines driven respectively by a tandem-compound Atlas engine and a cross-compound built by the Bass foundry. The Western Electric dynamos, driven by a Watertown double-tandem compound, an Erie City, a New York Safety, and three small Russell,—all simple engines,—occupy the space at the extreme west end of the power-plant.

The electric-power generators are all located by the east end of the plant east of the Brush block. There are two tandem-compound Woodbury (Stearns Manufacturing Company) engines driving four Mather generators, having a total of 800 horse-power. Two Ide engines, a tandem-compound, and a simple, drive four "C. & C." generators of 100 horse-power each. The Phœnix Iron Works furnish a good exhibit of three engines, a simple, a tandem-compound, and a four-cylinder triple-expansion,—which are used to drive four Eddy generators of 250 horse-power each. The E. P. Allis Company have a 500 horse-power cross-compound engine with a Westinghouse multipolar railway generator on the engine-shaft. There are four Edison 200 horse-power generators driven by a Ball cross-compound and an Armington & Sims simple, and also an Edison double multipolar generator aggregating about 1000 horse-power directly driven by a triple-expansion engine of the General Electric Company's make. These electric-power generators furnish current for motors driving line-shafts, elevators, and similar machinery in the Manufactures, Agriculture, and other buildings and for charging the storage-batteries of the electric launches.

Besides the engines in the electric plant, there are several which drive the line shafting in Machinery building. There is about 6500 feet of shafting divided into about eighteen sections. Two sections are driven by electric motors, but all the rest are driven by engines of various sizes located at points most convenient to the shafts which they drive.

There are among these two tandem-compounds of about 300 horse-power each from the Harrisburg Foundry and Machine Works, and B. W. Payne & Co., Providence Engine Company, Golden State Miners and Iron Works, the Bates Machine Company, and Erie City Engine Works. Each is represented among the "line-shaft engines." The Sioux City Engine Company have a 24x 48 engine which drives two long shafts from a double-crowned fly-wheel, the belts extending in opposite directions from the wheel. This Sioux City engine is the largest single-cylinder engine in the building. The E. P. Allis Company have driving one shaft a small vertical box engine of an entirely new pattern, designed to compete with the small engines of the cheaper grades.

The English and German commissioners furnish the engine power to run their respective exhibits. The Germans have a small triple-expansion marine engine of 150 horse power, made by Shichau & Co., which drives three parallel shafts with a rope-drive of the endless-rope system which is now becoming quite common in this country. By the side of this engine there is another of 1000 horse-power of exactly the same design as the small one. The large engine drives a Siemens & Halske direct connected arc-dynamo, which is used by the exposition company for lighting the terminal station. The English commission have three engines to drive their shafts. The most prominent of these is a Galloway compound-engine with superposed cylinders, which has a drive of eight parallel ropes. The other engines in the English space are Willans & Robinson vertical high-speed compound-engines. These engines run at 300 revolutions per minute and are made with very short stroke to reduce the piston speed.

Besides the electric and power machinery there are in the power plant several air-compressors, four of varying sizes from the Norwalk Iron Works, which furnish compressed air for the sewerage system. There is a large double Corliss compressor from the Ingersoll-Sergeant Company, and another Corliss, compounded in both air- and steam-cylinders, from the Rand Drill Company. These latter furnish air for running elevators in the Transportation building and various exhibits in that and the Mines building.

The total capacity of the engines in the electric and power plant, as taken from the economical (not the maximum) rating of their makers, is somewhat over 29,000 horse-power. Besides, a considerable amount of steam power is used by the pumping-station and by exhibitors in Machinery hall and the Mines building, to which latter a 9 inch steam-pipe is run from the boiler-house, a distance of about 1500 feet, so that the plant is fairly estimated at 30,000 horse-power.

All the piping for this immense system of machinery is, as far as possible, located beneath the floor. The main steam header is located under the platform in the boiler-room, the boilers feeding into it by pipes, which cross the boiler-room near the roof and drop into the header. This header is 36 inches in diameter, built of boiler iron, and runs the entire length of the boiler-room and annex, about 800 feet. On account of the expansion, however, it is divided into seven sections, the longest of which is 150 feet, and this one expands nearly four inches under steam at full pressure. The adjacent sections of the header are connected by expansion loops of 10-inch wrought-iron pipe, which serve to equalize the pressure. Laterals are taken out of the top of the header and run across the power plant under the main floor with branches to the different engines. The condensers are supplied with water from seven Worthington pumps located at the extreme east end of the power plant, which take their water-power from the lagoon east of Machinery hall. There is a double 24-inch main running from these pumps down each side of the basement of the engine-room. The overflow-pipe which takes the water from the condensers is, at its largest section, 40 inches in diameter. There are about thirty condensers of varying sizes, representing nearly all the prominent makers and types, in this country, whether of surface, or injection-condenser, or air pumps. Most of the condensers are placed in the basement, though a pit is cut in the main floor, so that the condensers may be seen from above. The condensers for the big vertical Westinghouse engines are placed above the main floor and are the largest in the plant. There are, among these, two Wainwright surface condensers, with Blake combined air and circulating pumps, and two Wheeler surface-condensers, one with a Blake and one with a Knowles air-pump. On the other two of these engines are Worthington jet-condensers.

The boiler-feed pumps and feed-water heaters should also be mentioned among the machinery exhibits of the power plant. The feed-pumps are in the firing room, just opposite the boiler-fronts. Prominent among these is a large triplex-geared power-pump by the Goulds Manufacturing Company, which is driven by a small Ide engine direct-coupled. Among the others are exhibits from nearly all the makers of small steam-pumps, showing every variety in design and construction.

The feed-water heaters are all exhaust-heaters, and most are of the pressure pattern. Though much the larger proportion of the engines are condensing, there are several high-pressure engines, and the exhaust from these as well as from the feed-pump is used for heating the feed-water. Most of the condensing-engines also have a connection to a free exhaust to provide immunity from accidents to the condensers. Among the heaters, two large Baragwanaths and a Kroeschell are conspicuous as examples of the pressure type, and a Hoppes and an immense Webster of the open type. There is also a big double Colles heater, which is a combination of both forms.

To the engineer possibly the most interesting exhibit is found in the vitals of the plant, concealed in the basement. Though difficult of access and uninviting, even threatening in some ways, there is an inspiring impressiveness in the net-work of huge pipes, —steam, exhaust, injection, and overflow connection,—the whirr of tons of rapidly-revolving fly-wheels, the clatter of a hundred belts and dizzy spin of the counter-shafts, the measured beat of condenser-pumps and the hiss of steam from an occasional leaky joint, all among the dark shadows of the huge masonry piers which form the engine foundations. Beside the power plant, the entire Machinery building is intersected by a net-work of steam-pipes for supplying steam to exhibitors. The entire building contains 900 feet of 16-inch lap-welded pipe, over a half mile of 12-inch and 14-inch pipe, and more than a mile of 6-, 8-, and 10-inch pipe.

There might also be included in the electric and power plant the distribution of electric light and power throughout the grounds. The arrangements and setting of the thousands of lights, the miles upon miles of wires and cables which interlace the grounds to its uttermost extremes, and the methods of carrying these in ducts and conduits, and the wire-walled electric subway, the limits of this article scarcely permit us to consider. To Mr. C. F. Foster, the mechanical engineer, and Mr. R. H. Pierce, the electrical engineer, and also to Mr. F. Sargent, who was formerly the mechanical and electrical engineer, are due the design, construction, and erection of this great work,—the greatest of modern power plants.

ELECTRICITY.

Conducted by Franklin L. Pope.

SOME of the technical journals which devote themselves especially to electrical matters have taken exception to certain observations which have from time to time appeared in these notes, in reference to the tendency which has become increasingly apparent of late years, to establish electric-lighting and electric-railway plants under conditions that forestall the possibility of an adequate return to the capital invested in them. One of the leading electrical journals, while not attempting to traverse the essential accuracy of the statements made, contends that one remedy suggested—that of raising the price of electric-lighting service to a remunerative point—is not to be thought of. It asserts that the real source of the trouble lies in the cheap and unscientific manner in which these plants have been installed, and in the false economies and generally inefficient management in vogue in many of the smaller central-station plants. It apparently overlooks the fact that the first count of this indictment, if true, would constitute a scathing arraignment of the engineering and business methods of the half-dozen or so "parent" companies of the country, under whose auspices and instructions nearly all these local plants have been installed. As to the second point, it is difficult to believe that all or even any considerable number of the small plants are seriously mismanaged. There are too many of them in the same predicament, and the figures run too near alike in the different places to render this conjecture a plausible one. The amount of careful and intelligent service rendered on many of these small plants by their attendants, for inadequate compensation, would surprise one who had never had occasion to investigate the subject. One thing is certain, and that is, if 1 cent per lamp-hour is a fair price for incandescent lighting in a city of 100,000 inhabitants, it is much too low a figure in a rural municipality of 5000. Another journal has attempted to refute an opinion expressed some months ago in these notes that the electric-railway business was in great danger of being overdone, having reference more particularly to the extension of new lines not in towns, but along country highways, and through sparsely settled districts intervening between such towns. Our contemporary professes to quote from the street-railway returns of Massachusetts to prove what no one has undertaken to dispute, viz.,—that the aggregate percentage of net earnings to total cost is 6⅛ per cent. for the electric lines, and only 5½ per cent. for the horse lines. This reminds one of the assertion of the knight of the road that the average amount of his income and Vanderbilt's, taken together, was several hundred thousand dollars per annum. We do not know from what source our contemporary derived his figures, but our copy of the Massachusetts report for 1893 gives 592.3 miles of electric- and 322 miles of horse-railway, instead of 235 electric and 262 horse, as he has it. The average cost per mile of electric-railways, including roadway and equipment, is given by him as $30,631, and that of horse railways as $29,550, which is manifestly absurd. The Massachusetts railroad commissioners' report says that the average cost of *all* street-railways, including equipment, is $47,356 per mile, a somewhat important difference. We have no doubt, however, that the difference in the ratio of cost to net earnings, in the case of the electric lines now in operation, is fully as great and even greater than our contemporary states, and it is for the very purpose of maintaining this average, by advising investors to be cautious about putting their money into unprofitable lines, that we called attention to the matter as we did. The installation of non-paying electric plants is quite as injurious, in the long run, to the stockholders of the electrical manufacturing companies as it is to the immediate investors. It is certain, in the end, to make it extremely difficult to raise capital for legitimate and necessary undertakings of this character. The real trouble is, in our opinion, that the electrical industries of to-day are being carried on for the pecuniary benefit of promoters, salesmen, and drummers, rather than in the interests of the capitalists whose money is invested in the business, or of the public which is entitled to good service at reasonable prices. The financial prosperity of the great electrical companies must ultimately come to depend wholly upon that of the local electric-lighting and -power companies, and the fact cannot be gainsaid that the official returns demonstrate that these are by no means as prosperous as they should be. It is much the wiser policy to determine the cause of the unfavorable conditions which exist and apply the proper remedy than it is to seek to deny the facts.

MR. EDISON has been giving some advice to would-be inventors through the columns of a metropolitan contemporary. Some of his advice is excellent, and some of it is quite otherwise. The thing to seek for, he says, is the machine or the process which will save labor. This is emphatically true. By far the larger share of the so-called "inventions" which cumber the records of the Patent Office are either devices for doing that which nobody cares to have done, or else they embody a somewhat different, and no better way, of doing that which was well enough done before. Such contrivances, however ingenious they may be, are a mere waste of time and money. The money is made, says Mr. Edison, in the little inventions and not in the great ones. This is also true in a measure, but not for the reason alleged by him, which is that, if the invention is of real importance, it will be pirated as soon as a patent is applied for, while the inventor can only establish his rights after a long, tedious, and expensive course of litigation. Therefore Mr. Edison advises that an invention had best be kept and worked in secret, and no patent applied for. Mr. Edison, however, has conspicuously neglected to follow his own advice, having taken out, up to date, some seven or eight hundred patents, probably a greater number than has been taken by any other inventor in the world. He has been constrained to do this for the reason, if no other, that at least 90 per cent. of all inventions made are of such a nature that it is quite impossible to keep them secret, if any use whatever is to be made of them. How would it be possible to maintain secrecy in respect to such inventions as the telephone, the telegraph, the cotton-gin, the reaping-machine, the electric-motor, and a thousand others like them? The pirating of patented inventions, of which Mr. Edison so loudly complains, is not chargeable to our patent laws, and still less to our courts. It is due to unregenerate human nature, which causes each man to be consumed with an unappeasable desire to appropriate the fruits of his neighbor's industry, no more in respect to patent-rights than to every other valuable result of human endeavor. The whole machinery of our courts of justice is maintained for no earthly reason except to prevent and punish the infraction of one man's rights by another. Experience shows that, when a really original invention has been made, and the patent claims are properly drawn to protect it, would-be infringers are apt to be very wary of incurring the penalties of transgression. If a man buys a farm and accepts an incorrect deed,—one which fails to describe the property, or which describes some other property which he has not bought,—it does not look well for him to cry out against the laws of the land or the procedure of the courts, in case some sharper person than himself takes advantage of his defective title to oust him from the premises. Mr. Edison observes parenthetically that his own fortune has been made in manufacturing and not from patented inventions, but we are inclined to believe that, if the articles he manufactured had not been protected by patents, he would not have found the business of manufacturing them extraordinarily profitable. It is really, we think, rather late in the day to question the policy of the patent law of this country, which, in spite of its admitted defects, has unquestionably been the principal factor in making us the leading industrial nation of the world.

THE report of the American Bell Telephone Co. states that it has now under rental no less than 552,720 telephones, an increase of over 40,000 for the year. There are now 812 exchanges, and an aggregate mileage of wire of 307,791,—90,216 miles of which is underground. The estimated number of exchange connections made for conversation is about 600,000,000 per year. Great progress has been made the past year in the establishment of trunk lines connecting the different exchange systems, and the number of interexchange connections made during the year was about 13,000,000. The use of the telephone by its subscribers appears to be increasing, as its convenience becomes more appreciated. Each subscriber, on an average, is placed in communication with others in the same exchange sixteen times per day, while six years ago the average was only 11.6. With the recent extensions and additions to the system, more than one-half of the total population of the United States have now been brought within talking distance of each other, and it is a fact that a man may sit in his office-chair in New York and speak directly to any one of 125,000 telephone subscribers, some of them over a thousand miles distant. The gross revenue for the year from telephone rentals was in round numbers $3,000,000, being a little less than $6 per instrument, from which it appears that this rental, which includes the patent royalties, is but a very small fraction of the annual cost of the service to subscribers. The high price in New York city, as we have more than once pointed out, is largely due to the enormous expense entailed upon the telephone companies by the subway system.

A WRITER in the London *Electrical Review*, after a careful examination of the whole matter, reaches the conclusion that in England the electric light in most cases costs considerably more than gas, but points out that the difference in cost to the householder is nearly counterbalanced by the avoidance of the constant expense of repainting, repapering, and redecorating the interior walls of rooms, which have been deteriorated by the smoke from the gas-burners.

THERE has been a vigorous contest in the legislature of Connecticut over the provisions of the proposed general statute for the regulation of electric-railway enterprises. As finally passed, the bill permits the paralleling of existing steam railroads, provided the courts can be convinced that the public interests require it in any particular case, which is perhaps the wisest disposition of the matter that could have been made. Freight may be transported under similar conditions. Our own view of the matter is that the steam-railroad companies will ultimately find it for their interest to control all the profitable and well-located electric lines, and will operate them on a coupon-ticket system as feeders and distributors of their local passenger traffic. That this might be done in many cases, with the greatest possible advantage to all concerned, is obvious upon the most casual consideration of the matter.

THERE are not a few people who imagine that, if the telegraph service were only turned over to the government, we should soon have vastly increased facilities at lower prices. But the experience of some other countries seems scarcely to justify such an assumption. The well-known London correspondent of a leading New York newspaper, who is making a pilgrimage through Germany, states that in Berlin, a city of 1,750,000 inhabitants, there are only fifty-eight telegraph-stations, all told. In Dresden, with 250,000, there are only ten, and in the important city of Hamburg, which is twice as populous as Dresden, there are only fourteen. The fact is, as every unprejudiced observer is well aware, that the telegraphic service of the United States, in spite of all its faults and shortcomings, is, all things considered, far in advance of that of any other country in the world. Not only is there almost a superabundance of offices in almost every town of commercial importance, but in all large cities one has but to touch a button in order to secure, within a minute or two, a messenger to convey the sender's telegram, without charge, to the nearest office, a thing undreamed of in any other country. The charges, moreover, are not exorbitant, as is frequently alleged; there are in fact few kinds of business in which the actual percentage of profit is smaller than it is in telegraphy, as carried on in the United States at the present day.

THERE is now attached to the French navy a torpedo-boat which is propelled by electricity and carries a store of compressed air for the respiration of her crew. It is said to be capable of maintaining a steady course eight meters beneath the surface of the water, for a distance of 500 meters, traveling at a speed of about four knots per hour. It is also said to have remained under water as long as forty minutes at a time. A Spanish boat of similar construction is cigar-shaped, 9½ feet in diameter at the thickest part and 72 feet long, and can make, under water, a speed of six knots per hour. It is reported that a considerable number of sets of plans and specifications for submarine torpedo-boats have been submitted to the United States Navy Department, and are now under consideration. A Chicago inventor is said to have constructed a boat of this character, in which two men have remained submerged, without serious discomfort, for a period of nearly two hours. The use of electricity as a motive power had immensely simplified the problem of producing a practicable submarine boat, and we may reasonably expect some very remarkable developments in this line at no distant day.

PROFESSOR BLAKE, of the University of Kansas, has made an interesting comparison between the light of the sun and the artificial light produced by electricity as exemplified in the illumination of the grounds of the World's Columbian Exposition. According to the experiments of Professor Langley on Mount Whitney, it appears that the energy received by the earth's surface from the sun's vertical rays amounts to 1.6 kilowatts per square meter, of which some 35 per cent. is in the form of light. The area of the exposition grounds is computed at 4,200,000 square meters, and hence to light this space by the sun must require an expenditure of energy equal to 1,466,400,000 watts, or 1,965,000 horse-power. Assuming the statement to be correct that 5,200 arc and 90,000 incandescent lamps are employed to light the grounds, the energy required would be about 14,200 horse-power, from which it appears that nature expends about 140 times as much energy as man in the illumination of the total area covered by the World's Fair.

THE American Institute of Electrical Engineers has established its headquarters in the gallery of the southern end of the Electricity building at the World's Fair, overlooking the grand plaza. Besides a well-stocked electrical library, and files of the professional and other journals provided for the convenience of visitors, a very interesting collection of sketches, models, and relics will be on exhibition; among other things one of the original models of the electric railway, made by Thomas Davenport, the Vermont blacksmith, early in 1837. Extensive preparations are making for the Electrical Congress, which is to meet on August 21.

THE West End street-railway of Boston is making an experiment in the way of a continuous track, formed by electrically welding the joints of the existing rails. The welding plant is mounted upon a box-car, and the power is derived by a connection directly from the trolley wire. The ends of the rails are first cleaned by the application of an emery wheel operated by a small motor, after which the welding clamps are applied and the current turned on. The time occupied in welding each joint is from five to ten minutes. Besides the physical advantages of smoother riding, and less wear and tear of rolling-stock and track, it is expected that the conducting capacity of the track for the return current will be materially enhanced. Investigations already made show that there is little trouble to be apprehended in respect to the effect of changes of temperature on long lines of continuous rails.

A SECTION of street-railway in which the electric current is supplied to the motor-cars from underground conductors is now in experimental operation on Coney Island, N. Y., which embodies some novel features, and appears to possess many elements of success. The conductors are thoroughly insulated, and are only put into connection with the car at the moment of its passage. The contact devices are placed in a conduit, and are successively brought into operation by a metallic shoe attached to the car. This idea, broadly speaking, is not new, but the manner of its application is certainly novel and ingenious, and its operation appears to be very satisfactory. The inventors of this system have apparently made a long step towards the solution of one of the most difficult problems of the day.

THE substitution of electricity for horses on the street-railway system of Brooklyn has now progressed to such an extent that nearly half of the total number of cars in use in that city are running by electricity. The change in motive power has been accompanied, as it has everywhere else, by an enormous increase in the volume of traffic. Indeed, it is said that the effects of the competition are beginning to be seriously felt by the elevated steam-roads. More powerful engines are being substituted for those formerly in use, and the speed of the trains has been increased as much as practicable. It is probable, however, that the general increase of travel, due to better facilities, will soon make good any temporary loss of patronage which may have been suffered by the elevated lines.

NO electrical device ever invented has attained half so great a popularity as the little rotating fans, which are adapted to be placed on a table or desk, and connected with the electric-light service, and will thereafter give a continuous and refreshing breeze for any length of time at the trivial cost of one cent or so per hour. This is perhaps the cheapest comfort to be had in the market at this time of year, although riding on the front platform of an open electric car on a pleasant summer evening at the rate of half a cent per mile is a close second to it. The rotating electric fan was invented and patented many years ago by a South Carolinian, but, most unfortunately for him, the patent expired before the introduction of cheap electric service rendered the fan a commercially valuable invention. Still it does seem a pity that the inventor of such a beneficent little contrivance should go wholly unrewarded. If every one who uses one of the fans should contribute not more than a dime, he would soon be rolling in wealth.

A GENTLEMAN of Brookline, Mass, has frequently appeared on the streets of that aristocratic suburb, mounted upon an electric carriage of unfamiliar and possibly terrifying aspect; but an irate citizen, whose favorite horse objects to the appearance of the new competitor, has filed a petition with the municipal authorities for its suppression. There was a great deal of fun at the hearing, but the probable upshot will be that the "electrical tortoise," as somebody called it, will be allowed the freedom of the town. The modern horse might as well make up his alleged mind first as last to accustom himself to a great many strange and uncanny sights. It begins to look, by the way, as if he might ultimately become a strange and unfamiliar sight himself.

AN electric railway has been constructed in Japan for the purpose of transporting boats between the ocean and a high-level inland lake.

MECHANICS

Conducted by Leicester Allen.

SINCE the matter for this Department for the July issue was prepared, there have been several events of interest to marine constructors. The first was the exhibition of remarkable speed which the *Campania* is capable of under favorable circumstances. This noble steamer has developed one of those surprises of which she was predicted to be capable by "A Clyde Engineer," in his interesting paper in this Magazine, written before she had made her first voyage, although not appearing until after her arrival in New York harbor. In making her record of 548 miles in a single twenty-four hour run, she exceeded by about 18 miles the record of the *Paris*, which had hitherto been the best day's run ever made by a steamer on a westward trip. On the following day she also made a record of 532 miles. While this may possibly be due partly to her model, nothing but the very best construction and design of her engines and boilers would have enabled her to accomplish this great feat. Another notable event is the successful launching of the United States battle-ship "Massachusetts," from the yards of the Cramps at Philadelphia.

A marine event which is recorded with great regret is the sinking of the English battle-ship *Victoria* through a collision with the *Camperdown*. Besides this very unwelcome evidence of the destructive power of the beak peculiar to our modern war-ships, it has brought to prominent notice the peculiar distinction existing between the respective effects produced by the impact of a very heavy body moving at a low velocity, and of a much lighter body moving at a very high velocity. The latter, while it can penetrate deeply, thus, producing a small opening through an obstructing body, does not produce nearly so extensive a rupture as the former. Of course this holds true with reference to the modern system of armor plating, in which resistance to the penetrating power of projectiles moving at very high velocity has been very greatly increased. It may be that ramming by war-ships will prove to be their most formidable means of attack in future marine warfare.

THE shipbuilding industry appears to be languishing on the Clyde, while the very opposite condition is seen in the most prominent shipyard of the United States, that of the Cramp Company at Philadelphia. From English papers it is gathered that prices obtainable for vessels built at the Clyde shipyards have shrunk till there remains little or no profit in the business; and that, notwithstanding the fact that contracts for merchant steamers can now be made at about half the price possible a year ago, there is a serious falling off of orders. *Per contra*, at the Cramp Company's yards in Philadelphia there is the greatest activity. There are 4500 men now employed at these yards, and the company will, it is stated, immediately proceed to greatly enlarge the capacity of their present plant. When the contemplated enlargement has been completed, the company will increase their pay-roll to 6000 men.

NOTWITHSTANDING the great anticipations that were cherished on the part of the projectors of the international congresses to be held in connection with the World's Columbian Exposition, and the cordial approval of the scheme accorded to it by the technical press throughout the world, the interest of the general public in the congresses has, so far, disappointed their promoters. The truth is that those who go to the exposition for the most part do so simply to gratify their sense of the wonderful, the magnificent, and the beautiful, and to see the strange foreign faces costumes, and customs that they never expect to have an opportunity to see anywhere else. Beyond the merely superficial knowledge they can acquire through hasty observation by the use of their eyes alone, they do not wish to learn anything; this fact is daily becoming more pronounced. Nor is this to be wondered at, when the nature of the exhibition and the nature of mankind are considered. A vast collection of curious and interesting objects is to be seen, and in ninety-nine out of a hundred cases those who want to see have limited time and limited purses. To attend the congresses they must sacrifice a part of their time for doing what they came to the exhibition principally to do,—namely, to see the show; and they find, when they get there, that the show is so much larger than they had any conception of when they started from home, that to see it, even in the most cursory manner, they must economize time to the utmost. Even those who started out with the resolution to devote a part of their time to attendance upon some one or more of the congresses, when they stand in the presence of the mighty collection that solicits their admiration, will be, many of them, fain to say: "We have no time to attend congresses. This is a so much larger contract than we expected that we must set aside all subordinate purposes." The more important congresses are, however, yet to come; and numerous papers will be read by eminent men on a great variety of subjects. Nearly all of these papers will appear in print, so that, after all, the trouble and expense of holding the congresses will not be lost. The literature of technology will be enriched, and, in the opinion of the writer, by none of the congresses more than the one in which the American Society of Mechanical Engineers will have the opportunity to exhibit to the world the ability of its membership.

INCREASED attention to the health and comfort of workmen in shops and factories is manifest on the part of many leading establishments. A conspicuous example of this has recently been made public, in the provision of improved bathing and washing facilities in the well-known works of J. H. Williams & Co., Brooklyn, N. Y. These works are devoted to the manufacture of drop-forgings, an industry which, like most of the operations in iron working, exposes workmen to the discomforts of heat and the accumulation of black dust on their persons and clothing while at work. The comfort and luxury of facilities for rapid and complete ablution of the entire body at the dinner hour or at the close of the hours of labor for the day can easily be imagined. To provide such facilities the firm named has fitted out a large and commodious wash-room, affording space for a large number of men to wash and bathe at the same time, closets for dressing and for the retention of clothing being also supplied. The bath-tub system has been set aside in favor of shower-bathing, for the reasons that the latter requires much less room, and that thorough cleansing can be more quickly accomplished in the latter method of bathing than in the former. In shower-bathing pure water constantly replaces water that is soiled in washing, and, though it might at first seem that more water would be consumed than would be needed if tubs were used, experience in shops has shown that less water is wasted by having the workmen wash in running water than if they are allowed to draw it into sinks, buckets, or basins. The example set by the enterprising firm named might well be followed by other manufacturing establishments, not only out of consideration for the welfare of the men employed in them, but because those who have observed the effect of personal cleanliness in shops have universally declared it to pay excellent interest upon the outlay required to secure it.

THE method of manufacturing tubes known as the "Mannesmann" process has justly commanded admiration on account of the simplicity of the means employed to produce the desired effect. Before the invention of the process, few would have been found to credit the possibility of the production of a tube by a simple process of rolling. Like the standing of an egg on the end, the method seems feasible enough when one is shown how it can be done. Now we are told that another method of making tubes has been invented by a German mechanic, Herr Ehrhardt, of Dusseldorf. The tubes are made of steel, and at a single heat. The method, in the first stage, is somewhat analogous to punching. It gives promise of success particularly in the manufacture of seamless tubing of moderate lengths. The method consists in placing a bar of steel of square cross-section in a matrix of sufficient strength having a hole of the exact diameter of the outside of the tube, and then, without giving time for cooling, forcing a mandrel having a rounded end, lengthwise, centrally into the matrix and centrally with respect to the heated bar which is held from moving longitudinally in the matrix. The bar out of which a tube is to be made by this curious process must have square cross-section of the size of a square inscribed in a circle having the diameter of the hole in the matrix that limits the size of the exterior of the tube and gives it its external form. The area of the cross-section of the mandrel would seem, therefore, to be limited to an amount equal to the difference of the areas of the inscribed square and of a circle having a diameter equal to that of the hole in the matrix. A little thought will enable it to be seen that, if this supposition be correct, the thickness of the shell of the tube formed in this first operation must bear a fixed relation to the exterior diameter; and this appears, unless it can be explained away, one of the disabilities of the process, resulting in the limited length of the finished tubes that, as yet, has been found practicable. The process is, however, still in the very infancy of its development, and it is extremely interesting as exhibiting the extent to which the flow of metals, can be rendered available in mechanical processes. In this process the metal is forced to assume the form of a hollow cylinder around the mandrel, between the latter and the inner surface of the matrix. It is said that a difficulty which would be likely to suggest itself to mechanics--namely, the tendency of the mandrel to deviate toward one side of the mold—does not materially interfere with the success of the process unless there be some imperfection in the quality of the material worked. It is also said that tubes of 7.88 inch internal diameter have been made by the Ehrhardt process, the pressure required to operate the mandrel for a tube of this size being 180 tons. The end of the heated bar farthest from the mandrel is at first made to abut against a very strong and heavy slide; and when the rounded nose of the mandrel has nearly passed through the bar, this slide is moved transversely so as to bring a hole in line with the advancing mandrel, which, continuing to move, punches its way through; its protruding end is then seized by tongs, and entirely withdrawn. The above operation completes only the first stage in the process. The tubes are finished by drawing and redrawing till a length is obtained corresponding to the size of the original bar and the required thickness of the shell.

ANOTHER new valve-motion invented by Mr. David Joy, known everywhere to steam engineers as the inventor of the valve-motion to which his name has been given, is attracting atttention as possibly having in it the promise of a very wide application to all kinds of engines that require to use reversing gear. In this invention Mr. Joy has reverted to the employment of the single, shifting eccentric that ranks among the earliest devices used for reversing steam engines. This device, when moved, as formerly, by sliding wedges, was found to be mechanically defective, and upon the invention of the link-motion it went entirely out of use. The defects were not inherent in the shifting-eccentric, which effected all the control of the valve sought for; but they pertained solely to the means for shifting the eccentric across the axis of the crank-shaft. Other means than the sliding wedges were devised, but the link-motion (one of the most beautiful mechanical movements ever devised in connection with the steam engine) became so popular that, for a long time, little attention was given to the problem of reversing valve-motions. To Mr. Joy belongs the credit of devising a valve-motion in which the movement was derived from the connecting rod instead of the crank-shaft, and this has been used in competition with the original link-motion to a greater extent than any other valve-motion that has been invented since the first introduction of the link-motion. This eminent inventor has now provided a means whereby the shifting-eccentric may be operated without any of the disabilities of the old sliding wedge movement. He forms cylinders on the eccentric into which plungers attached radially to the shaft are fitted. Through the shaft is formed a longitudinal passage for oil, the oil being forced through a small steel tube connected both with the passage in the crank-shaft and with a small force-pump on the foot-plate of the engine. Accordingly as the oil is forced into one or the other of the cylinders on the eccentric under the plunger therein, the eccentric is forced across to one side or the other of the axis of the crank-shaft. If the oil be equally forced into both cylinders, the eccentric takes a position corresponding to the mid-gear of the link-motion. The *Engineer* (London), in which has been recently published an illustrated description of this new motion, speaks very enthusiastically of it as being very much cheaper than the ordinary link-motion, more easily manipulated than the link-motion, and fully equal to it in the control of the admission of steam to, and the exhaust from, steam cylinders.

A GOOD deal is said and written nowadays about the moral obligations of employers to feel an interest in the private lives of their employés, and particularly about their obligations to exert a sort of paternal care over the habits, associations, and education of the young men and boys in their establishments. There is no denying that, if this could be carried out in the sense implied by those who advocate such a course, both employers and employed might be benefited; the former, in obtaining a higher standard of honesty and integrity in their service, the latter, by an influence that would tend to elevate them in the social scale, and to protect them from the many besetting temptations to folly and misdoing that assail youths of the period.

There is no doubt that under the now extinct system of apprenticeship which formerly existed, when all sorts of mechanical trades were carried on in small shops, and when those serving their apprenticeship lived in, and were substantially a part of, the families of their masters, there was generally a higher tone of morality among mechanics than there is at present. The masters had an authority over apprentices then which, if they chose to exert it, was scarcely inferior to that of a parent over children. It is to the credit of those "good old times" that, in the majority of cases, this authority was more or less exerted; and that it was considered an element of prosperity in an employing master, in any of the trades, that he had a reputation of being strict with his apprentices, both in the trade instruction he was bound to impart and in the supervision of their associations and habits. Such a reputation, coupled with a reputation for liberality in the treatment of apprentices, as regarded their food and lodging, enabled a master in any trade to enlist in his service the brightest and most desirable youths in his immediate vicinity, and thus supplied his shop with more intelligent and reliable workmen than it would otherwise have been possible for him to have obtained.

BUT the times have changed, and with them have gone such possibilities. Beyond contributing to and aiding in the support of night-schools, libraries, reading rooms, etc.,—all good in their way,—and such very brief supervision as he can give in his occasional surveys of his establishment, which, for the most part, is left in charge of his superintendent and the foremen of departments, it is entirely impossible for a proprietor of a modern manufacturing establishment to exert any strenuous influence upon the private life of those employed in his business. Even his personal example, which may be excellent, fails of effect upon his wage-earners,

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because his life is, and must be, almost wholly apart from theirs.

One thing, however, might be done by proprietors, which would be beneficial to all youths in their establishments. The superintendent should be selected as a man not only of skill in the conduct of business, but as a good man, and a good citizen; and he should be held responsible for the selection of foremen who not only possess skill in their respective departments, but who are also good men and good citizens; and these should be given to understand that they are not merely engaged for making the young men in their departments serviceable through training of hand, and eye, and mechanical judgment, but, by example, to exert a salutary influence upon their habits,—to advise, and, if need be, to reprove anything coming to their knowledge in the lives of the men under their charge, that tends toward evil practices. It is to be feared that in many manufacturing and commercial establishments even this kind of supervision, the only one that remains practicable under the altered conditions of industry, is either very perfunctorily attended to or altogether neglected.

The production of the flexible metallic tubing invented by M. E. Levavasseur, would certainly have been impossible with such tools and appliances as were available forty or fifty years ago. It is a notable example of the extension of modern engineering resources. A tube approximating in flexibility a rubber hose, that can withstand an internal pressure of 300 pounds per square inch with safety, and is so substantial in construction that a cart can be driven over it even when there is no internal pressure to assist in preventing the collapse of its walls, is indeed an acquisition. The numberless uses to which such tubes can be applied will suggest themselves to the mechanical reader without any specification of them in this Department. The origin of the invention is interesting. It is the outcome of an idea that has gradually evolved in the mind of the inventor, and which has grown out of the manufacture of a kind of jewelry that was popular between 1870 and 1880, not only in France, but in England and America. People will easily recall to mind the bracelets and necklaces referred to, which had the form and appearance of a tube built up of laminated sections each overlapping another, so that, when the articles were wound about the neck or wrist, they had a strong resemblance to the scaly form of a serpent. Later M. Levavasseur improved the manufacture of this kind of jewelry, each article being made of a single coiled strip in which the convolutions were ingeniously made to interlock each with the adjacent convolutions. This brought to his consideration the possibility of making a water-tight flexible tube of metal having a construction similar to the necklace described, except that the joints were made tight by interposed rubber packing. After patenting the invention in this form, the inventor found that the joints could be made tight without the employment of rubber packing, by a series of ingenious mechanical processes, and the result is a flexible tube that is steam- and water-tight. Doubtless, for some uses, wherein the metal of these tubes is exposed to corrosive action, they would prove objectionable; but there are many fields of usefulness for such tubes. One of these is their employment as conduits for petroleum and other hydrocarbon liquids and gases. In a paper recently read before the Society of Arts, London, by Mr. Gilbert Redgrave, these tubes were described, and it was asserted they had been employed for conveying petroleum under a pressure of 300 pounds with perfect success.

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ARCHITECTURE.

Conducted by Barr Ferree.

THE Department of Architecture earnestly hopes that all who read these pages will make a visit to the World's Columbian Exposition. The Exposition is so vast, the matters of interest so numerous, that a conscientious visit is no light task, but it is impossible for one to regret it, and the remembrance of it will be retained as long as life lasts. One should not try to see too much, and it is better to see a small part of the Fair well than to see all of it after the usual American fashion of walking rapidly past a number of articles and remembering anything that may have struck one in the promenade. On this plan, which is an extremely simple one, if nothing strikes there was nothing there. Doubtless many thousands will visit Chicago this year on just this plan, but grotesque as it is there are so many points of interest that it is impossible to escape without some good thought, some fresh inspiration, some new idea. That this will be beneficial to the country at large is apparent from the class of people one meets upon the grounds. Even in the early months, before the excursion business had a ghost of a show, the grounds were filled with country-folk from way back, all intent upon the novel show spread out for their amusement and instruction, and all intent upon seeing as much as possible in a limited time. But alas for human intentions! The mind may be willing, but the body is weak, and one can get weaker in Jackson Park in less time than any other place on earth. Exhibition visiting is work entailing considerable fatigue, and when to this is added the fresh and uncalled-for misery of no seats, or very few of them, what was to be a pleasure becomes a task. Perhaps this is why the people take their pleasures so quietly. There is no holiday-making at the Fair, no public expression of jollification, such as would be part and parcel of an international exhibition in Paris. A visit to the exposition at Chicago seems to be a serious matter,—and so it is, thanks to the management and its policy of charging for everything save air. But Americans take their pleasures quietly, and are not given to making merry with strangers and chance acquaintances; so the subdued aspect of things may, perhaps, be put down as illustrative of a national trait. One word of caution may be added. However it may be late in the season, there are no signs of high prices and exorbitant charges in the early months of the exhibition. The hotel business has been so very much overdone that high rates for rooms are impracticable, and even the restaurant charges on the grounds, where the very highest prices would necessarily obtain, are by no means high. It is true the meals and service are not always of the best, and the lunch-counters err too much on the side of cheapness, but it is not necessary to exhaust one's bank-account, or mortgage one's real estate, to make quite a prolonged stay at the Fair.

THE American architectural drawings at Chicago form a good, fair collection, scarcely better than an average Architectural League exhibition, but representing very justly, on the whole, what American architects think good and proper to send to a public exhibition of this nature. This means, of course, that the "pretty" pictures predominate over the architectural ones, and that it is the popular eye, not the professional judge, which has been most thought of. Of water-color drawings there is an unusual number, some being of buildings, others fancy sketches or picturesque bits of foreign travel, very well done as a whole, but decidedly out of place in an architectural exhibition. Such work as this had better been put in the

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water-color rooms of the exposition. If one were justified in generalizing on distinguishing traits of architectural work from the drawings shown at Chicago, it would appear that American architects make freer use of water-color than foreign architects, or certainly much more so than English. But this doubtless comes from the idea of pleasing the general public in exhibitions, or in tickling the fancies of unarchitectural committees in competitions, for, generally speaking, the rendering of a large building, and especially of a large business building, in water-color, is an unnecessary operation. As architecture goes in this country, and considering especially the nature and kind of drawings prepared for public inspection, it is difficult to see how the collection could have been bettered. This does not mean, if you please, that it is the best thing under the sun, or that the collection is something to fill the heart of every architect and architectural student with pride and joy; it is simply as good as we do. Like the manufacturer who boasts that his exhibit at the Fair consists only of stock goods taken from his regular lines, the architects of America may justly claim to have sent only the drawings they had on hand. No one could accuse them of getting up displays especially for the occasion. It is, to put it bluntly, a stock exhibit, arranged and selected with a little more than the usual care. One must protest, however, against the old drawings, the relics of ancient competitions with which the collection is crowded. Why, for example, should Messrs. Carrère and Hastings bring out their drawings for the New York Protestant Episcopal Cathedral? These have been before the American public for a number of years now; they were rejected by the Cathedral trustees, and have scarcely more than an archæological interest at the present time. Further than this, this firm has done more and much better work since that is more worthy of a place in the collection. Quite a number of architects show cathedral competition drawings, Messrs. R. W. Gibson, William Halsey Wood, Parfitt Brothers, and several others being represented.

As is usual in American architectural exhibitions, the drawings are chiefly façades. Few sections and plans are shown, and no hint whatever given of the influence which current methods of construction have upon architectural design. An exception to this is supplied by a young gentleman from Paris who contributes a vast series of large drawings illustrative of what he calls a "country mansion." This is conceived and carried out in the most abominable taste of the French Renaissance, and with the utmost disregard of cost and utility. The drawings take up a great deal of room that might have been much better occupied, and it would be interesting to know why the committee admitted it. But here it is, and it calls for one good word, since the author has been generous in his sections, though his design is bad and his conception worse. The two great strong points of American architecture, the country house and the high building, are illustrated in a variety of ways and in a variety of styles. On the whole the country house is sufficiently well illustrated, as is also the country church. One cannot help asking, however, why Messrs. Peabody and Stearns should have sent their frames of—it i difficult to get the right word to describ them, since though done with water color they do not warrant the dignity of being called water color—small churches The artist, if such he may be called was so eager in his search for the picturesque that his imagination ran away with him, and he has only succeeded in producing sketches that illustrate what ough not to be done. The high building i scarcely as well represented as it shoul have been. Apparently the canons o taste of the different committees differe so widely, and so much difference o opinion exists as to what constitutes well-designed high building, that almos anything could get in and did so. Y some fine drawings of fine buildings a shown, notably a very large water color the Ames building in Boston, which, no withstanding its size, scarcely does t structure justice. Mr. Bruce Price e hibits his wonderful study for a thirty-tw story office building, which the New York *Sun*, when it has nothing else to say, is constantly threatening to build. No drawing is more likely to attract the attention of foreign visitors than this; it is a very serious attempt to solve a very difficult problem. It is, however, only an attempt, and should not be considered a finality. Some notion of the incompleteness of the collection may be gathered from the fact that Messrs. Adler and Sullivan are represented only by a single drawing, that of their Union Trust Building at St. Louis, and which, strangely enough, is hung apart from the mass of the drawings.

AFTER inspecting the English drawings, one returns to the American collection with a sense of satisfaction. It is difficult to imagine a less representative collection than that purporting to illustrate the work of the British architects. If the American architects have gone back five or six years to unearth old drawings, the English have gone back twenty or more. In fact, some of the drawings are so ancient that it requires no stretch of the imagination to suppose that they have remained in this country since the Philadelphia Centennial. Mr. R. Phené Spiers, who certainly is not dead, since it is only a short time since he read a long paper on Italian architecture before one of the English architectural societies, sends two drawings done in 1876, both very bad in design and in rendering, and both quite unfit to send from London to Chicago for the purpose of instructing the barbarian Americans in all that is good and true and beautiful in architecture. Quite as blamable is Mr. J. Oldrid Scott, who figures extensively in the catalogue, and whose contributions include, among other things, a huge "New Town Hall for Manchester" and a similar structure for Hamburg, in which latter drawing he was associated with the late Sir G. G. Scott. Neither of these things, fortunately, has been erected, but both are at the very least twenty years old, both are very bad in design and in rendering, and both are things any architect may well feel ashamed to have produced. But apparently their author and the English architectural committee deemed them worthy of sending four thousand miles that foreigners may see them. It is quite impossible to explain the presence of such drawings at Chicago save on the grounds that no one knew they were being sent or else the opportunity and occasion were not appreciated. Had English architects wished to express their utmost contempt for America and things American they could not have done it more clearly and precisely. American architecture in its latest development is not a sealed book to English architects; the work of American architects is quite well known in England, though not so well as it should be. Mr. Scott's horrible Gothic town hall for Manchester is not only a depressing exhibition of what an architect is capable of doing, but its presence at Chicago is a positive insult to American architects. A very large part of the English collection was apparently selected on the grounds that anything would do for America, and accordingly anything was sent. Yet, though there was every reason for making the collection a representative one, it is impossible for any one who has followed the development of English architecture as reflected in the illustrated professional press to accept it as such. English architects can do better than they have shown here; why, then, did they not give some evidence of it?

AND they have. For, bad as many of the English drawings are, there are many others which are not only very good in their way but absolutely so, and go far to redeem the general degradation of the collection. A number of churches are shown that are well worthy of attentive study, and, though few important buildings are exhibited, several, as notably Mr. Ashton Webb's design for the completion of South Kensington Museum, are of the first rank. This drawing, which has been rendered by Mr. Raffles Davison, who stands in the very front of living English architectural draftsmen, merits attentive study as an example of draftsmanship. Such delicate pen drawing as this is not produced in this country; line drawings and water colors being the favorite mediums with us. But this drawing, and a number of others, likewise in pen and ink, show how very much superior to American draftsmen the English are. Some drawings shown by Mr. T. G. Jackson, notably his "New Front of Brasenose College, in the High Street, Oxford," are especially remarkable in the care lavished upon them. It is true that many of these drawings closely approximate engravings in appearance, and not a few of them require careful examination to show they are not engravings, but they are nevertheless most notable examples of pen-drawing. Beautiful as they are, they must be criticised for their small size. Mr. Davison's drawing of the South Kensington Museum, for example, is on so small a scale that no detail whatever can be shown. Many other drawings are almost microscopic in scale, which, though well suited to the style of rendering employed, is quite improper for representing important architectural construction. In fact, whatever be the mode of rendering adopted, the English architects seem to prefer a much smaller scale than is usual in this country. Many of our own drawings are entirely too small, but the English architects are much worse. Most of the large drawings shown in the English section are very bad indeed, both in subject and in rendering, though whether all these things be connected organically it is impossible to say. For design the English section has little to interest American visitors, but in architectural draftsmanship it has much both of interest and of value, and that notwithstanding the presence of some very bad drawings.

STRANGELY enough, the French make the poorest architectural display, England, France, Germany, and America being the only nations which make any pretence at illustrating architecture to any extent. The entries in the catalogue show seventy-five numbers for France and 144 for Great Britain; the former includes an unusual proportion of decorative sketches, so that the actual number of architectural drawings is very small. This must be a great disappointment to the Frenchites of America, as before the exposition opened they must have anticipated worshipping at the shrine in Jackson Park and calling upon the world to do likewise. As a matter of fact there is nothing in the French section which warrants in the least the marvellous hold French architecture and its system have upon architects in America. Neither is there any special indication that French architects are doing any important public or private work at this time. If one takes out the drawings for foreign structures,—and it may be well to note that no hint is given of their actuality or not,—there is very little French work left; and if from this is removed the restorations and studies of the antique and medieval remains there is almost nothing left to show either what French architecture is doing or can do. In its way, therefore, the French collection of architectural drawings is much more disappointing than the English, since one naturally expects more of it. The most noticeable drawings are the restorations and studies, a kind of work which forms a delightful pastime for French architects, and especially for French architectural students, and which is not known in this country save to those personally familiar with the methods and processes of French architecture. All these drawings are on a very large scale, offering a most delightful contrast to English and American work in this respect, and they are further noticeable in actually illustrating the constructive features. In other words, when a French architect makes a drawing, he produces an architectural illustration. To him, as to every right-minded architect, the plan and sections, as well as elevations, are more important than the production of picturesque drawings. He does not disdain perspectives, but the plan and sections are more essential. And yet with all the following of French ideas in current American architecture this very important feature has been overlooked. This is the chief lesson the French drawings at Chicago teach; no one must look for originality or even design.

THE German drawings are noticeable

for their really immense size and generally uninteresting design. Large as the French drawings are, they are greatly exceeded by many of those in the German section. And these gigantic drawings are very useful to study and are one of the few things American architects may profitably take heed of. The smallest building is a large object to depict on paper, and the building can be so much more readily studied, the detail can be so much better illustrated, the whole effect is so much clearer in a large drawing that it is much to be regretted that current American practise is towards small ones. At all events no greater contrast than the immense drawings of the Germans and the minute pictures of the English architects could be imagined, and the advantages are clearly on the side of the former. Quite a number of these drawings are done in India ink, and others in crayon with a stump pencil, the result being a lithograph-like drawing such as is not shown by any other body of architects. The professional man can find no more profitable occupation at the Fair than making a comparative study of the styles of rendering in vogue in the different countries, all of which are very well illustrated there. But apart from the interest attached to the rendering there is little of value in the German architectural drawings. Like the English and French, the Germans seemed to have thought it desirable to send some drawings made years ago, a number of which have evidently been included. More interesting than the drawings are the plaster models of German buildings, likewise shown in the Fine Arts Palace, where they make an imposing show from their large size. The most important of these is a model of the German Houses of Parliament at Berlin, executed on quite a large scale, which shows the detail very fairly. The building is a familiar one to American architects, and therefore it need not be described here. French in conception, it is carried out with a German feeling of uncertainty and unfamiliarity with the style that robs it of natural expression. Two models of Romanesque churches, one a memorial to the first emperor, the other the Gnadenkirche in Berlin, are also shown. Both are new buildings designed in the German historic Romanesque, which may very properly be called the German national style. They thus gain a special interest as pointing, perhaps, to a revival of a former style, in which German architects once worked with freedom and ability, and which was susceptible of a higher development than it received.

It is earnestly to be hoped that architects and engineers in visiting the Fair will avail themselves of the opportunity to study the real merits of Chicago architecture, as illustrated in the best of the high buildings of that city. More than once, in these pages, we have pointed out how much more thoroughly the Chicago architects as a class appreciate the structural limitations of design in high buildings than their brother architects in the East. Not all of Chicago's high buildings are good,—many of them are very bad,—but on the whole the expression of the conditions underlying the high building are better shown in Chicago than in any other city. But one must put away one's prejudices before he can properly appreciate what the city has to show in commercial architecture. One must be prepared to see buildings sixteen stories high with no horizontal lines save those of the basement and the frieze, to see bays one and two windows wide and ten stories high without a break and without the additions and so-called ornament that make up the larger part of high-building architecture in the East. No building is better worthy of study, in this respect, than the Monadnock, which not a few, perhaps, would class as engineering alone, without any architecture whatever, so plain and solid are its walls, utterly unrelieved by anything save the windows. It is interesting to compare the older part of the building, in which this system of designing is best illustrated, with the new part now rapidly nearing completion. The addition, which covers as much ground as the original structure, is by different architects, who, however, approximate the style of the older part while making it somewhat more ornate.

Quite as interesting, and quite as impressive, also, as a study in designs, is the Old Colony Building, by the same architects, Messrs. Holabird and Roche, and which, likewise, is rapidly nearing completion. Here is nothing but the architecture, or rather the walls and windows, to attract attention, yet it shows what can be accomplished by the use of the simplest elements in the simplest manner. Chicago has no more impressive business building than this, and the system on which it has been designed warrants attentive study.

ARCHITECTS in general, and Messrs. Adler and Sullivan, of Chicago, in particular, must be amazed at the competitive design for the Buffalo Real Estate Exchange submitted by Messrs. Roberts and White, which was recently published in *Architecture and Building*. No design was ever more openly and deliberately copied from another than was this from the design prepared for the Union Trust Building at St. Louis by the Chicago architects. The copy is so direct and complete as not to be a compliment to Mr. Sullivan. It is not creditable to the Buffalo architects that they should have allowed their appreciation for a good thing to get the better of their judgment and permit them to make a servile copy of a contemporary's work. It is bad enough to appropriate the designs of previous ages, but altogether intolerable to take that of a living fellow-man, though in morals there is, we presume, no difference.

Mr. Sullivan's design for the St. Louis building is an extremely striking and effective one. The main façade shows an external court flanked by two masses, whose chief feature is, in each, three bays carrying round arches and running through ten stories. The basement consists of two stories, of which the second is filled with large circular windows. This is the ornamental story of the building, the motif of the decoration being a lion standing upright and holding a shield between his paws. The building is finished with two stories above the arcades, in which the windows are separated by columns, and with a strongly-marked curved cornice ornamented with the rich and delicate carving Mr. Sullivan has so thoroughly stamped with his own individuality.

In Messrs. Roberts and White's design —which, it happened, was not successful in the competition—the basement consists of three stories, of which the second is very high and plainly finished, while Mr. Sullivan's circular windows, carving, lions, shields, all appear in the third. Above, the building is divided by an external court into two bays, treated with arcades six stories high, as against the ten used by Mr. Sullivan. The building is completed with a two-story duplication of Mr. Sullivan's two stories, followed, as might be expected from what precedes, by the same cornice, similarly decorated. In both buildings the entrance is through a large archway placed between the two wings of the building, though Messrs. Roberts and White, it is proper to say, have introduced a treatment of their own.

All this transference of another man's work to another building and another locality may be intended as a compliment to the originator of the design, but such servile copying is to be most severely reprehended. It is one thing to develop an idea imperfectly understood or incompletely worked out by another, but it is quite different to take all a man has done and give him nothing in return. There is gradually developing, in American architecture, a tendency to appropriate the designs of other people, and the instance we have cited is only going one step further than any one else has yet gone. But the taking of this step should be a warning to every right-minded person that we are drawing very near to the verge of deliberate dishonesty. It is time we drew back from the precipice; perhaps this example will help to point a lesson that there never should have been occasion to learn.

INDUSTRIAL CHEMISTRY

Conducted by Dr. R. A. Witthaus.

DR. FRANCIS WYATT, in his contribution on the "Progress of Chemical Industry" to the statistical volume recently published by the *Engineering and Mining Journal*, makes these following interesting statements:

> In a series of essays published in the *Engineering and Mining Journal* in the year 1887, I made an effort to show that, of all the arts which we had cultivated and improved, the manufacture of chemicals had made the least progress and received the least attention. This did not apply to our production of sulfuric acid, for which we were at that time consuming about 90,000 tons of imported brimstone and 100,000 tons of native and imported pyrites, and in which we were able to compare favorably, if not in cost, at least in practice, with that of the best in Europe. The unfortunate circumstance that the great bulk of our acid was made from high-priced brimstone constrained us, however, to confine its use to the refining of petroleum or the manufacture of fertilizers, and none of it went into the production of alkali and soda salts. Our small output of these was derived either from the "ammonia" process or from the decomposition of cryolite; and as we were making no chlorin, or bleaching powder, the mass of our dyers, paper-makers, and glass- and soap-manufacturers were practically dependent upon our imports for the most essential elements in their raw materials. More than five years have elapsed since those essays were written, and although our general onward march in industry has been a rapid and triumphant one, so little change has taken place in this important branch that the picture then drawn might also be used to represent it now. Our manufacture of sulfuric acid has certainly increased, and we have kept abreast of the times by adopting many new appliances for the avoidance of waste and the lessening of cost. We have also, thanks to the energetic advocacy of Adams and other earnest workers, made substantial advance in the direction of pyrites consumption, and have thus placed ourselves on a more equal footing with European competitors. Beyond this we have done little worth recording, and have no reason for self-gratulation or complacency. The American chemical trade has grown to be the prop and mainstay of the United Alkali Company of Great Britain! The American chemical industry is of proportions so insignificant as to be almost a negligible factor, and gives us no voice in fixing the market values for either alkali, soda salts, bleaching compounds, or dyes and coloring matters.

This is a sad commentary on American enterprise, but every one who is in touch with these branches of chemical industry knows this to be the true situation. Dr. Wyatt has recently spent considerable time in Europe, and the opportunities of this visit give added force to his words. But a brighter era is approaching. The LeBlanc process is still struggling for existence and the ammonia-soda method striving for supremacy; but the discoveries of Mond and Gossage in supplying a cheaper method for recovering the waste chlorin promise important advances toward lessening the cost of production and improving the product. Both of these modifications the Gossage to the LeBlanc and the Mond to the Solvay process, have passed beyond the experimental stage and are reported to have withstood severe tests on the industrial scale. Chemical ingenuity and unlimited capital have combined to solve the problem of cheaper heavy chemicals in Europe, and it will be interesting to observe the effect of all this experimentation upon these industries in America. We are in a position to produce the raw materials used in our soap, glass, paper, and bleaching industries cheaper than they can be made anywhere else in the world, and coal, limestone, and salt are almost as cheap in America as in England. With the raw materials, the capital, and the market there remains only the economic process to transplant the greatest of chemical industries from England to America.

DR. WYATT estimates that the cost of producing sulfate of soda or salt cake in England is $7.30 per ton of 2240 pounds, and bleaching powder, packed ready for shipment, $15 per ton of 2240 pounds. Before this can be made available in the United States there must be added for freight, insurance, and import duty, about 35 per cent. of these costs. The cost of production in the United States is shown to be: Sulfate of soda or salt cake, $7.70 per ton of 2240 pounds; bleaching powder, $16.76 per ton of 2240 pounds. Surely these figures are favorable to the home production. The production of soda ash in the United States by the ammonia process has increased steadily from 10,000 tons in 1884 to 50,000 tons in 1888 and 82,000 tons in 1892.

The per-capita consumption of salt in the United States is about one bushel of 56 pounds, and already the salt industry is paralyzed by over-production. The old process of solar evaporation has given way to more rapid methods by steam and blast, and the system of working the brine is being replaced in some sections by the sinking of shafts and mining the salt in bulk. The market price of dairy salt has fallen to 49 cents per barrel, of which the barrel costs 23 cents. There is no profit in salt at such figures. The natural outlet is not in cheapening the cost of production by substituting mining for boring, but in utilizing the salt in the manufacture of alkali and bleach. Mond's modification of the ammonia-soda process, the application of electricity to obtain a greater proportion of chlorin, or such an improvement in the LeBlanc process as that proposed by Gossage, promise to open the way for American manufacturers to successfully compete with the United Alkali Company. Indeed, the recent words of Professor George Lunge, who, more than any one else, is in a position to know, would seem to be prophetic when he says, "We poor Europeans may well tremble as we think of the enormous advantages for all applications of electricity enjoyed by the United States with their unbounded water-power, coal-fields, and oil-wells, not to speak of natural gas. In all human probability they will soon cease to be importers, and may even become exporters of bleaching powder."

PROFESSOR HERBERT E. SMITH, chemist to the Connecticut State Board of Health, has recently completed an examination of Connecticut river in its relation to the public water supply of Hartford, and his report is published in the fifteenth annual report of the Board. The water supply of Hartford is taken from storage reservoirs by the gravity system, but pumps are maintained at the river to be used as a source of supply in an emergency. No such emergency occurred between December, 1884, and October, 1891, a period of about seven years. The Connecticut river was used as a source of supply from October 3 to December 8, and from December 22 to the 30th, 1891. Immediately following this change of water-supply there appeared, in the returns made to the Board of Health, a notable increase in the number of cases of typhoid fever, and this unusually high rate of death by typhoid continued during the months of December, 1891, and January, 1892. This is an unusual period of the year for an increase in the death rate by typhoid, and yet the number exceeded that customary during the summer months. This coincidence led to the investigation, and Dr. Smith's conclusions are stated in the closing paragraph of his report as follows. "From the evidence presented, it has been concluded that the recent use of the Connecticut-river water in Hartford has been the cause of typhoid fever in that city, and that there is little reason to believe that the germs came from the sewers of Hartford, but from some point above. The water in the river just above Hartford must be as pure as at any point in this State, consequently it is unsafe to use for drinking at any point in Connecticut."

ARRANGEMENTS have recently been completed by which a new impetus will be given to the manufacture of aluminum,—metal and alloys. The Pittsburg Reduction Company has entered into a contract with the Cataract Construction Company for 6500 electrical horse power and has nearly completed plans for a building near the Niagara Falls Tunnel. It is stated by Dr. Alfred E. Hunt, president of the company, that the Cowles Aluminum Company, now using water-power of Eighteenmile creek, near Lockport, will be removed to Niagara, and occupy a portion of the plant being constructed for the Pittsburg Reduction Company. This is the largest amount of power thus far contracted for by the Cataract Construction Company and is sufficient to produce aluminum in large quantities. Bauxite, from Alabama, will be used as the ore.

DR. RICHARD P. ROTHWELL, in closing his editorial comment on the statistics, technology, and trade of the mineral industry, writes: "There has been no increase in 1892 in the total value of the mineral products of the United States as estimated in these tables, nevertheless the production of most of the minerals and metals has increased in quantity materially. It is natural that, with increasing facilities and competition in producing, both costs and market values should decline, and in most cases profits have also been less than formerly. The disadvantages this vast country labors under in having to transport its raw material and manufactured goods enormous distances to market, with consequent high cost for carriage, are being overcome in part by the creation of markets nearer the sources of supply; in part by the reduction in freights due to competition among railroads and the possibility of reducing charges by reason of increasing quantities carried; and in part by the great reductions in cost of producing which cheaper supplies, larger output, and greater experience, skill, and knowledge of the business have rendered possible. When coal is carried by rail at one quarter of a cent per ton-mile, and many other articles pay less than half a cent per ton-mile, distance becomes a less important element in the development of an industry. That coal is delivered on board vessels 400 miles from the mines at $2 and $2.25 per ton, and both mines and roads make satisfactory dividends; that it is mined at a fair profit, though sold on the railroad at the mines for, say, 65 cents a ton; that hard, free-milling gold ores are mined and milled at $1.25 a ton and 95 per cent. of the gold is extracted from sulfid ores at a treatment cost of $2.50 a ton; that copper ores are mined, milled, concentrated, smelted, and refined at $1.50 a ton, and 62 per cent. high-grade Bessemer iron ore can be delivered a thousand miles from the mines at, say, $3.50,—that such instances of cost of production are possible with average wages at from $2 to $3.50 per day, and that the cost of transportation added still permits these selling prices, are mentioned as examples of the best present practice, and not as examples of average costs. The average commercial cost of producing any article is the average minimum cost at which so much of it can be produced as the market demands. The more expensive producers are the first obliged to stop; the most economical, the fittest, survive, and regulate the market. The enormous progress in the mineral industry of the United States which is shown in these eloquent statistics has been due chiefly to increasing knowledge and experience in the arts involved. The great reduction in costs of production has in most cases been accompanied by a decided betterment in the condition of the wage-earning classes, if not by an absolute increase in the rates of daily wages. Skill and knowledge count far more than the rates of wages in the successful prosecution of an industry. Nor is the importance of knowledge by any means confined to the 'captains of industry' or those who create or develop it, but it is quite as important in the workmen. The introduction of greater skill and knowledge which result in improving the quality of the work and increasing the output per man per day is the most effective and satisfactory manner of bringing about a reduction in cost to the producer; while no advance in wages ever asked for or received could so greatly benefit the wage-earners as would greater knowledge of *their* business by the wives and daughters of workers. A better knowledge of what and how to cook, of how to keep house, and of the common rules and means of promoting health would be of incalculable benefit to the wage-earners, bettering their condition in many ways, and it would at the same time indirectly tend to promote economy and success throughout the entire industry. The unbounded natural resources and the intelligence and marvelous energy of our people have brought the development of many departments of the mineral industry to the point where, exceeding the home consumption, we must open the wider markets of the world, and make of this country a workshop for supplying other and less fortunate nations."

IN regard to the management and development of the Florida fields, Mr. C. C. Hoyer Millar contributes an admirable paper to the *Manufacturer's Record*. It is Mr. Millar's opinion that Florida will retain the pre-eminent position as a producer of high grade-phosphate. "Although in the past the financial results have been unsatisfactory in most instances," he says, "yet this forms no ground whatever for supposing that the hard-rock industry is not a sound one in itself and likely to prove lucrative at all events to those companies which are directed with good business judgment combined with solid practical management." The rash sales of the Florida companies in Europe have forced the mines of the Somme department of France, whose annual shipments have exceeded 100,000 tons, out of the foreign market, confining them chiefly to the home market and the Rhine. The excessive supply was not, however, the principal cause of the low prices prevailing last year; the market is good and steadily increasing. The stagnation is rather to be preferred to the extraordinary and unbusinesslike methods of marketing the Florida phosphates in Europe, and the absence of paying dividends for the same cause. Phosphate was offered at figures below the cost of mining, and large sales were made before the mines were touched or the mining machinery ordered. Such a course as this must naturally result in disaster, and the prosperity of the companies adopting such foolish methods will be materially decreased. Nor has the low market price been of benefit to the manufacturers abroad; they too have been obliged to cut prices, and a strong competition has resulted between those who bought at the lowest figures and those who did not.

Basic slag has come into the market since 1887, but the production of phosphate has increased from 500,000 tons in 1880 to 1,303,000 tons in 1890 and 700,000 tons of basic slag. Mr. Millar strongly advocates a combination among phosphate producers as the best solution of the question as it now stands, and not only among the Florida miners themselves but also at least a definite understanding between them and the South Carolina producers. The latter, while they have a slightly greater expenditure in placing their phosphate f. o. b., can put it in the European market at a somewhat lower freight than their Florida brethren. In urging the combine Mr. Millar takes the stand that "buyers would rather pay a higher price if they felt secure against a drop in prices than buy at a lower figure and be haunted by the possibility of a further fall."

MINING AND METALLURGY.

Conducted by Albert Williams, Jr.

A RECENT Supreme-Court decision in a mining suit involving the transfer of a very large sum of money is of considerable interest, especially because the case has been before the lower courts for years, and has at various times had a favorable leaning toward one litigant, soon to be turned in the other direction, so that those who have followed its variegated career have been looking with much curiosity to the final outcome. It illustrates a train of circumstances often likely to occur in the history of partnerships in mining property. In brief, the facts on which judgment was finally rendered, were somewhat as follows: Two men jointly owned a mine. One was the active, resident partner or manager; the other was absent, a silent partner, and dependent on his colleague at the mine for information as to its character, value, and changes in outlooks as developments progressed. It appears that the absentee did not get all the information that the court thought he should have had. An important discovery of ore was made. Before this, the absent partner had offered to sell his interest to the managing partner for a stated consideration, in the belief that the property was not valuable and that there were no promising indications of paying ore. The managing partner, it seems, had previously stated in a letter to his brother that the indications *were* very promising, and shortly afterward a local paper reported the finding of a small amount of ore, with the expectation that it would lead to more. Later this paper announced that the expectation had been realized. After this a contract was signed by the managing partner reciting that "a lode or vein is now believed by all to have been struck," but he cautioned his family by letter not to inform the absentee of the discovery. The sale was made. Then the seller, the absentee partner, went into court to have it set aside, and this is what, under different legal complications, the fight has really been about ever since, though the issue has appeared in a suit for either recovery of interest with share in the profits or damages. The ruling declares: "It was the duty of the managing partner to disclose the true condition of the mine; and a sale on the terms offered by the absent partner, who continued ignorant of the discovery, could be rescinded by him in a bill in equity." As thus succinctly and baldly stated, the facts and their judicial conclusion seem clear enough. In detail, they were complicated and the evidence somewhat contradictory, so that the hesitation of the lower courts was natural enough. It should be noticed, as a delicate point in the case, that it was not the knowing manager who proposed the transaction, but his ignorant partner who voluntarily went into it. In fact, there was a plexus of nice points to be adjudicated not stated in this necessarily crude summary. But the main issue is clear—that in mining transactions concealment of information is equvalent to deception. It is a good precedent.

AMONG the exasperatingly wishy-washy, pseudo-plausible, quasi-axiomatic paragraphs floating in the all-receptive current of "patent-outside" journalism may be found the following, taken from a paper published in the mining regions:

> It is never economy for a manager, proprietor, or foreman to put his own labor in the mechanical department, or do such work as could be as fully well done by hired help at small cost.

On its face how sensible it seems, but how like a truism, how like one of Ben Franklin's pithy sayings! And what a convenient cloak with which to cover one's laziness, false pride, or ignorance of mechanical and technical details! But it won't do in the mines. There are plenty of situations where it would be not only a waste of time and effort, but decidedly bad policy, for a manager to take hold with his hands. To meddle with subordinates' duties unnecessarily and often would be mere fussiness and would ruin discipline, besides wasting time that could be more profitably employed. But to say that it is *never* economy for a superintendent or foreman to do manual work is absurd, a mere theoretical assertion of some one not a man of affairs. He often *has* to. It is his business to understand the details of whatever work he is superintending, and if possible understand them better and also carry them better than his subordinates if need should arise. If he has the skill and dexterity to *do* the work better than they, and can on a pinch take off his coat and show them how, why the men will respect him for it and will learn from him. They despise a fussy man, but like a useful one.

In managing a mine or a metallurgical plant, especially where things are on the small scale and the superintendent is alone with one foreman, not being able to afford a trained technical staff (who, by the way, would come under the same category with them) to look after details, emergencies constantly arise where, in the absence of skilled and specialized labor, he may be the only competent man about. Suppose a new piece of machinery is to be set up or an extraordinary repair to be made, is the manager or foreman to sit under a big umbrella at a distance like an old-time mandarin engineer and send messengers to the men with suggestions or (if they need animating) with threats of disemboweling? Or like an Egyptian slave-driving foreman (as depicted) ride about in a palanquin and be fanned while pointing out with the lash what is to be done? Very likely both these personages understood their business,—that is, considering their time, place, and social conditions; but they went the wrong way about it, judging from the standpoint of our time and conditions. That an accomplished professional man should break his nails and bark his knuckles laying fire-brick arches seems a queer proceeding and misdirected energy at first hearing; but if it is explained that there was no one at hand who knew how or could do it right if merely told how, it seems not only creditable but decidedly practical. Why, in many European technical schools they teach just this sort of thing; used to teach hand-puddling in the iron metallurgy course, in fact; and teach these manual operations to men designed to begin active work as officers. On the other side, fancy a $10-a-day boss-machinist in a large hoisting works walking about with a silk hat and gloves simply explaining and dictating, or an underground foreman too proud to help set a power-drill.

A man who has passed through the several stages of a technical occupation, if he has intelligence and ambition, has found that brains count more than muscle; that he can render more efficient work and earn better pay, generally speaking, in the former than in the latter line. But that will not exempt him from manual work when it is expedient or necessary. Then is the time when brains directing and combined with muscle in the same person are needed. When the emergency is over, he can wash his hands and put on his coat again. It is a failing of too many, when they have risen to a little authority, that they can't see this,—a failing corresponding to that of the clerk who thinks himself above the mechanic.

READERS of the article on Leadville which appears in this number of THE ENGINEERING MAGAZINE will be struck with the wonderful persistence of this famous silver-lead mining camp, notwithstanding a rate of exploration and exploitation unparalleled in any of the older or the foreign mining districts. The individual mines suffer vicissitudes and finally become exhausted one by one; then, or rather while this process is going on, new areas are being steadily found and opened and new mines enter into the list of producers, so that the district as a whole has maintained a remarkable uniformity and steadiness of output, notwithstanding temporary and individual set-backs or strokes of good fortune. In this respect it has resembled a community of men, who are born, run their course and fall from the ranks, but whose places are constantly being filled,—a condition resulting from the wide area of ore-bearing ground and from the very large number of individual mining ventures. Since the date when Mr. Wuensch wrote the article in question, the flurry in silver quotations has of course had a most depressing effect. Yet, in spite of this, as in spite of all former troubles, we may look to see this old reliable district in activity for many long years to come.

THERE is reason to believe that the problem of utilizing the immense banks of anthracite culm in Pennsylvania—and, indeed, all coals too fine for use in ordinary boiler-furnaces—is on the point of being successfully solved. This will probably not be done by any expensive system of briquette-making, which has had long trial and great ingenuity expended upon it, without thus far any very promising results commercially; but by the use of modified grates, furnaces, and boilers. Mr. Eckley B. Coxe, who is high authority on the subject, after long experiment, has brought out improvements in furnace construction. Another inventor is reported, who was not at all interested in saving the culm, but who has proposed to actually crush lump coal to a fine powder, and use it somewhat in the same way that petroleum is burned by the atomizing process. The idea is theoretically sound. Success in carrying it into practical effect is dependent on overcoming mechanical difficulties. It certainly seems reasonable to think that coal in fine comminution ought to give a very perfect combustion because so thoroughly acted upon by the oxidizing draft, and consequently abate the smoke nuisance if the blowing out of the particles in short stacks can be prevented, as it is claimed can be effectually done.

IT is announced that several new plants to use the iron-matte or pyritic smelting method for gold and silver are projected to be built in the west. The smelters now using the process have been very successful in treating low-grade pyritic ores, and the cost is reported at not over $2.50 a ton. One principal economy is in utilizing the sulphur as a large part of the fuel. Another is now proposed by introducing hot blast, the blast to be heated by waste heat from the slag.

IDAHO miners have peculiar ideas as to the reasonableness of grounds for going on strike. Last year the union men struck for the payment of the same wages for common labor as were paid to skilled miners underground. Lately, and at a time when a large proportion of the silver mines had closed, or were about to close down on account of low prices for the product, they went on strike again, notwithstanding there were already so many men idle. There is evidently an opening for the professional workman and walking delegate among the Idaho miners, to inculcate a little common sense in selecting time and cause for a strike.

SPEAKING of the experiments being conducted by the Tennessee Coal, Iron and Railroad Co., at one of its furnaces, the *Engineering and Mining Journal* calls attention to the importance which they have to many of the Southern iron-men, and says that, should they prove successful, as they now promise to do, they will open a wide field to the furnace-owners who have relied on their pig-iron alone, and will now be able to produce an iron that will be adapted to the production of steel on a large scale. The *Journal* thinks that, if the Southern iron industry is to continue to prosper, the manufacture of finished iron and steel should be added to that of the raw product of pig-iron.

WHEN silver bullion touched 62 cents an ounce in the New York market in the flurry of June 29, it reached a figure less than half the standard American coinage rate of $1.2929 per ounce, and naturally caused consternation among the silver miners. A number of important mines, among them some that were in the best position to produce silver at low cost, were shut down, throwing thousands more men out of employment. As the smelters ceased or reduced purchase of ore, it was not policy to add to stocks of ores at the mines.

AMONG the many mineral resources of Colorado are its clays, which are found in great variety. Fire, tile, brick, and terra-cotta clays are largely utilized, but some of the finer clays have not yet received the attention they merit. The *Mining Industry* (Denver) reports an analysis of a sample of Colorado porcelain clay corresponding to standard China clay, and adds: "For years the *Industry* has believed that the clays of Colorado would eventually prove to be a source of great wealth, and that some time the manufacture of fine porcelain would prove to be a great industry." It may be further remarked that in new countries it takes a long time to discover, appreciate, and make use of all the different mineral resources. Those which first attract attention and are most eagerly sought for do not always turn out to be the most important in the long run.

IN the Oregon exhibit in the Mines building at the World's Columbian Exposition is a miniature hydraulic placer-mining plant, which is thus described by a visitor: "The placer mine consists of a bed of gravel fifteen feet long and six feet wide, with a sluiceway through the center. A small hydraulic ram throws a vigorous stream of water against the gravel bank, carrying the dirt down in the sluice where the gold is caught by the riffles, placed crosswise in the box. A number of Oregon placer-mining properties gave the gravel, 100 sacks of 150 pounds each. A clean-up is made after each sackfull is worked."

THE contention of the striking coal miners in Kansas, who went out because the rule of paying on total coal had been changed to that of paying only on coal passing over a screen of a certain size, is that 43½ per cent. of the coal mined in Kansas has not and would not be paid for; that they could only make 56½ per cent. lump coal, on which the schedule is based. The Kansas coals are generally very tender.

THE Tombstone (Arizona) *Prospector* has interviewed a mining expert who had returned from the Altar dry placer district in Sonora, Mexico. He gives the *Prospector* some remarkable information about that camp, which he says is very rich. There is but one company operating there at present, a New York syndicate. They have sixty dry washers operated by 120 Indians whom they pay 75 cents a day. Their returns average $1800 a week. The diggings are 60 by 80 miles in extent and as dry, hot, and barren as the Colorado desert. The nearest water is twenty miles distant and is packed on burros for domestic use. The gold is very coarse. Several pieces which he was allowed to take from a washer are worth from $5 to $20 each. He states that many chunks are found, mixed with quartz, that are as large as hen's eggs. He saw one piece which weighed ninety-six ounces after the quartz was cleaned from it, which was purchased for a trifle from an Indian. One man cleans up the machines every night. He is the only American in the place. The gold is all sold to the merchants around the camp, who take their chances in getting it out of the country without losing their lives.

THE commission appointed by the State of Pennsylvania to investigate the waste in anthracite mining has submitted its report, which is a very exhaustive and practical one, as might have been anticipated from the high professional standing of the gentlemen composing the commission. Attention is directed to the great importance of the amount of fuel that has gone into the culm, bony-coal, slate, and dirt banks, though now a smaller proportion of coal is thus thrown away, owing to the marketing of finer sizes. Better washing appliances and closer classification in dumping have had their effect. An attempt has been made to ascertain the probable average of the coal lost in mining and preparation, which is a difficult matter to establish, owing to the great difference in conditions in different mines and districts. The conclusion reached is that since mining began the coal won does not exceed 35 per cent., and possibly is not more than 30 per cent. of the coal originally contained in the spaces mined over; and that this may be raised to about 40 per cent. by second mining and recovery from the culm-banks. The total yield, including coal sold locally and used at the mines, has exceeded the shipments about 10 per cent. Assuming that for every ton produced 1½ tons have been lost, and taking shipments at 820,362,925 long tons and total production at 902,000,000 tons, together with an estimate of 19,500,000,000 tons original contents, it appears that 17,245,000,000 tons of marketable anthracite remain in the ground. For reasons cited in the report it is doubted whether the total yield won by the time the fields are abandoned will exceed 40 per cent. This means that about 6,898,000,000 tons more may possibly be expected to come out. This would give a new basis for estimating the number of years it will take to exhaust the three Pennsylvania anthracite fields (a much discussed question), if only some one would offer a reliable prediction of what the annual output is to be in the future. The report abounds in practical suggestions, and should be studied by every anthracite colliery manager.

A NEW form of trap for saving amalgam and mineral has been put in at the Hawkeye gold-mill at Deadwood, South Dakota. It is an inverted cone into which the tailings pass. Near the top are openings to allow water and light pulp to escape, the heavier sinking to the bottom, and thence drawn off through pipes. The principle is one that has long been adopted in one type of concentrators, but the details of construction are described as original.

NEWS of another find of diamonds comes from South Africa. They occur in a conglomerate at Clerksdorp. The discovery was made in cleaning up the batteries of the mill of the Gold Estate mining company, and they were then traced to their source. The stones are said to be of good size and shape, but green. Fifteen tons of the conglomerate tested for diamonds showed that owing to the hardness of the matrix it would be difficult to recover the diamonds without injury in the treatment.

IN April the product of the Johannesburg, South Africa, mines was 112,053 troy ounces gold, valued at $16.80 an ounce, or $2,100,800. Of this amount 18,707 ounces were extracted from tailings by the cyanide process, which is supplanting chlorination there. Nineteen of the mills in the district now use this process, with only one practicing chlorination.

A VERY strange story, but one not altogether without precedent, comes from Cripple Creek district, Colorado. It is said that a lot of gold ore milled there yielded something like $20 a ton more than the assay from a "careful sample—a sample as nearly accurate as could be obtained of the ore tested." Of course this is sheer nonsense. The ores of that district usually give a low percentage extraction of their known contents. The explanation may not be found in attributing any special ignorance or carelessness on the part of the sampler or assayer—though that is quite possible too. Gold ores are especially difficult to sample when part of the gold is coarse. After getting a rough sample down to four pounds or one pound, supposing that to be done accurately (which is a hard thing to be sure of), then the assayer, in taking his final crucible sample, must exercise special care, grinding down the whole to a very fine mesh and making sure that no gold wires or flakes stick in the screen.

GERMANY'S mineral output in 1892 was valued at $187,283,129, and that of the metals (partly included in the foregoing at $104,663,703, in American money. The minerals we presume to have been all of domestic production; but Germany receives large quantities of metalliferous ores from other countries for reduction in her metallurgical plants.

CURRENCY CLEARING-HOUSE CERTIFICATE.

[Suggested by Mr. EDWARD ATKINSON's paper ; see page 555.]

THERE are several forms in which Clearing-House Certificates could be issued. The details of such a measure would, of course, be put in legal form by counsel learned in the law. These examples are submitted merely as suggestions.

CLEARING-HOUSE CERTIFICATE.

Clearing-House of ________________________________

consisting of ______ Banks. Aggregate Capital $____________

This is to certify that the Bank of ________________________________
________________________________ has deposited with the Clearing-House Committee of this Association securities of the present value of ____________ Dollars, upon which this series of certificates has been issued for circulation by said Bank; such securities subject to be changed from time to time, and also subject to an agreement by said ________________ Bank to maintain the value of the securities deposited in said Clearing-House at a sum at least 20 per cent. in excess of the amount of certificates issued thereon. In default of redemption of the obligations of said Bank secured under these certificates on demand in lawful money by said ________________ Bank, this certificate will be redeemed in lawful money on presentation at said Clearing-House.

____
Register.

On the back of such certificate the bank of issue might have the customary form of a bank-note printed, if the tax on bank-notes is removed. Otherwise the obligation might be in the form of a check, which is not taxable as bank-notes are.

____ BANK,

________________ ________________________

Pay to the order of ________________________________

____ Dollars.

____
Trustee.

To the Cashier :

Payment of this check is secured by a deposit of securities with the Clearing-House Association of ________________ under the terms of the certificate on the back hereof.

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THE
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SOME FACTS ABOUT THE SILVER INDUSTRY.

By Albert Williams, Jr., E. M.

THE production of silver in the United States prior to 1845, aggregating perhaps a quarter of a million dollars, was derived mainly from the parting of the $21,500,000 of gold produced in the South. From 1845 to 1858 the output was about $50,000 worth annually, chiefly from the same sources. Silver-mining on an important scale in this country dates from the discovery of the Comstock lode, or the Washoe district, in Nevada, where gold placer-mining had been carried on in a small way, but where the existence of silver ore in quantity was not realized until 1858-59. Some native silver had been obtained from the Lake Superior copper region, but there was no real silver-mining.

When silver was discovered in Nevada, the gold resources of California and Oregon had already attracted a considerable population, whose main dependence was upon the mines. The stream of newcomers, pouring in over different emigrant routes, had in its course led to many discoveries of gold east of the Sierras; while hunters, trappers, and explorers had also found gold. The Pike's Peak rush to Colorado was in full force, too. Everybody was looking for gold and nobody thinking of silver. This extension of gold-seeking had evolved a set of hardy, adventurous prospectors and miners, preëminently fitted to seize upon a new and promising source of wealth. When the importance of the Washoe discovery became recognized, therefore, a rush of prospectors spread over Nevada in search of similar deposits, and later, in 1862-63, overflowed into Idaho and Montana, though always looking first for gold. The combined attractions of the two precious metals brought a wonderfully rapid occupation of wide areas.

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The next great event was the opening of the Leadville district, in Colorado, in 1878. By this time silver-mining had become a regular and important vocation in the West. Besides the Comstock there were many other active districts in Nevada, and also camps in Utah, Idaho, Montana, Colorado, New Mexico, and Arizona. The mining population had largely increased, as had also their knowledge of silver-mining, and an army of prospectors and miners stood ready to scour the country and take up new fields. Soon silver-mining began to outstrip, and finally it almost superseded, gold-mining in the vast area between the Sierras and the one-hundredth meridian.

Towns and cities have sprung up in this section as if by magic, some of them outrivaling older and larger communities in their adoption of advanced means of civilization; railways have been pushed until scarcely an important mining district lacks direct communication with its sources of supply and the distant metallurgical works and markets; manufactures have been inaugurated, agriculture has been stimulated. All this advance in so short a time is attributable to the influence of mining. But this region is not yet wholly self-supporting. It has to draw upon outside sources for a part of its supplies of food, machinery, and mining material. Its exports of produce are not large, cattle, sheep, and wool forming the principal shipments. Otherwise the great reliance is upon bullion exports,—gold, silver, lead, and copper. What would have been the present condition of the far West, but for the stimulus which silver-mining has given to its general development, may be imagined. Its agricultural resources are limited; away from the narrow rain-belts irrigation is necessary to raise a crop, and competition with the prairie States would be too severe if there were no local markets. Up to the present, without mining, the leading industries would have been grazing and wool-growing, which imply a sparse and unprogressive population. There would have been no great cities, few railways, no foundries, no smelting-works, and but little demand for skilled labor.

When silver-mining was begun here, we were ignorant of the geological conditions and mineralogical associations of the deposits, their mode of occurrence, and the likeliest places to prospect. In silver metallurgy we were especially deficient. There were no local precedents, technical schools, or trained engineers. Freiburg and Clausthal, the Ecole des Mines, and the Royal School furnished the first mining and metallurgical engineers. Subse-

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quently we had our own engineering schools, which are now fully abreast of those in Europe. Experience came to the help of the miners, who by dint of many experiments and costly failures gradually evolved the present system of American mining and metallurgical practice, which now leads the world and is the standard everywhere. We no longer import engineers; we export them.

In metallurgy the advance has been wonderful. Once it cost $100 a ton to either mill or smelt silver ore, and that very wastefully. The Washoe pan-amalgamation process for treating silver ores raw was an offspring of the old patio process combined with the arastra. It was gradually improved until the cost was reduced to $10 and $15 a ton, with a saving of 60 to 80 per cent. of the assay contents of the freest ores. Later it has been brought down as low as $4 a ton. The dry-crushing, chloridizing-roasting, and pan-amalgamation process was introduced for working more rebellious ores, especially those of high grade. Various systems of lixiviation have also been introduced. But it is in lead-smelting for the precious metals that the greatest advance has been made, and by this method the great bulk of the silver ores are now treated. Silver-milling is steadily giving way before smelting. Under the most advantageous conditions this process costs about $4 to $4.50 a ton, and saves 95 per cent. and over of the silver, gold, and lead. As an accessory, there is now the pyritic or iron-matte system of smelting, besides the older copper-matte system, both of which cheaply give a furnace product in shape for shipment and final reduction.

The metallurgy of silver has not reached a finality, but the margin for further improvement has been very greatly reduced. It has been found expedient to separate the mining and treatment of silver ores, the latter operation being conducted on a large scale at great metallurgical centers with the advantages of varied ore supply, transportation, cheap fuel and flux, and nearness to markets. Under this system mines sell their ore outright to the smelters, directly or through ore-brokers and sampling-works. Thus they are saved the expense of building and operating reduction-works, and the better results more than offset freight charges, commissions and smelters' profits.

Silver-mining cannot be discussed without some reference to gold mining. Of the important mines there are more which produce both metals in noteworthy proportions than there are mines distinctively of either gold or silver. The effect of a suspen-

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sion of silver-mining would be two-fold: (1) the cessation of work in the purely silver mines would turn (as it already is doing) men and capital into gold-mining, and thus *increase* the gold product; while (2) the closing of the mines producing both metals would *reduce* the gold output. The net result probably would be a gain in gold production, at least for a while.

Silver has also a close connection with lead and copper. The silver ore minerals occur in nature very frequently associated with those of the two "base" metals, besides which the latter are indispensable adjuncts in the smelting processes for the extraction of silver. While the lead ores (mainly galena) farther east run very low in silver contents, those west of the one-hundredth meridian nearly always carry appreciable amounts of silver. In fact few lead mines in the far West could be worked at a profit for lead alone under existing conditions, transportation to market being the great drawback. But with the included silver these western mines are now producing the great bulk of the domestic lead supply. The copper-mines of Montana (Butte), Colorado, and other districts yield much silver also. The copper-matte smelting process saves the silver, which may be subsequently extracted by electrolytic and other wet separating processes, together with any gold present.

It is impossible to state the number of men engaged in silver-mining, the value of plant and improvements, the cash capital involved, and many similar points. The eleventh census (covering the year 1889) does not help us much here, though an attempt was made to ascertain these facts. The census reported the number of men employed in gold- and silver-mining in the whole country at 57,307, including an office force of 873. Only 9585 "miners" were reported for these industries in Colorado, with other workers in connection with mining bringing the total up to 13,196. Now, the reports of the State mine inspectors show that there were then in Colorado fully 20,000 wage-working mine-employés, to whom should be added nearly as many men working their own mines, leasing, tributing, and prospecting. If the teamsters, mechanics, surface laborers, mill-men, and smelter employés are added, there cannot have been fewer than 50,000 men engaged in gold- and silver-mining and -reduction in the one State, of whom about two thirds should be set down to the silver-mining industry as distinguished from the gold interests. On this basis it may be assumed that there were 150,000 or 200,000 men engaged directly and indirectly in silver-mining in the whole country, with a population of say a million dependent upon that industry. The number is much smaller, since the recent closing of so many mines.

With respect to earnings, precious-metal mining undoubtedly makes a better showing than almost any other important industry. Until very recently the standard rate underground in silver-mines has been $3 per shift of eight to ten hours, with 50 cents added for special skill, as in operating power drills, timbering, etc. In some more distant camps $3.50 a day has been the standard, while on the Comstock and in a few other instances $4 a day underground has been maintained by the unions. Lately, owing to the reduced price of silver, the standard of rates has been cut, and in some cases a sliding scale, adjusted according to silver quotations, has been adopted. The cost of living in silver-mining camps is so much lower than formerly that, without regard to the exigencies of mine management, there is a natural difference of from 50 cents to $1 a day in wages.

A large proportion of the more important silver-mines are not owned in the States where they are located. There is a much larger amount of home capital in silver-mines in Colorado than anywhere else; yet even in that State probably the majority of the big mines are owned in the East and in England. As a rule, the older and more settled a mining region is, the more home capital proportionately is interested in its mines. The largest silver-mining investments in this country are held in New York, San Francisco, Denver, Boston, and St. Louis, in the order named. London long has been a leading market for American silver properties. Paris has not invested so widely, but its few ventures have been on a large scale individually.

It may be of interest to compare the production of silver in the United States with some other important products. Mr. R. P. Rothwell, in his statistics for 1882, estimates the silver output for that year at 64,900,000 troy ounces, worth at full coinage value $83,909,210. The director of the Mint estimates 58,000,000 ounces, valued at coinage rate at $74,989,900. As the Mint statistics have been followed mainly in this paper, we may adopt the more conservative estimate. As bullion in the open market, at the average price of last year, 58,000,000 ounces would be worth $50,750,000, which sum will be the basis of our comparison. The American silver of 1892 was worth, therefore, somewhat more than one-third as much as the pig-iron, one-third more than the copper, about half as much again as the gold, and not quite three times as much as the lead. It was less than one-sixth the value of all the metals, embracing, in addition to the above, zinc, antimony, nickel, aluminum, etc. Again, the commercial value of the silver was about two-thirds that of the anthracite, two-fifths that of the bituminous coal, and more than one-quarter of the total coal value. It was worth one-ninth more than all the building stone, and two-thirds more than the petroleum. It will be noticed that, while silver is of predominating interest over a large area of the country, it is surpassed in importance by some and rivaled by others of the more prosaic products when the whole of the United States is taken into account. The total silver production of the country from 1792 to the end of 1892 amounted to 887,082,527 troy ounces, worth $1,146,869,000 at the coinage value of $1.2929 per ounce,—the only figure available in this computation. During the same hundred years the output of gold in this country reached $1,937,881,769.

The following table shows the approximate distribution, by States and Territories, of the silver and gold production in the United States for the year 1892. It will be seen that the bulk of the silver produced comes from seven States, Colorado alone furnishing not far from half of the total for the whole country. Nevada, which long held the first place in silver production, has fallen to the fifth place. California, which has yielded the great mass of the total gold output of the country, produces comparatively little silver. The figures given relate to fine ounces troy:

STATES.	Silver	Gold.	STATES.	Silver.	Gold.
Colorado.....	24,000,000	256,387	Texas.......	310,000	......
Montana.....	17,350,000	139,871	Washington..	150,000	18,071
Utah........	8,100,000	31,936	Michigan.....	60,000	3,386
Idaho........	3,164,269	83,271	South Dakota.	60,000	178,987
Nevada.......	2,244,000	76,021	Oregon......	50,000	67,725
New Mexico...	1,075,000	45,956	All other.....	18,800	63,226
Arizona.......	1,062,220	51,761			
California	360,000	580,500	Total......	58,004,289	1,597,098

The total estimated silver yield of the world for 1892 was 152,061,800 ounces troy, of which the United States produced over 38 per cent., and Mexico about 30 per cent., these two countries supplying more than two-thirds of the grand total. South America and Central America combined slightly exceed the Australian colonies, the product of the latter being carried up mainly by the phenomenal output of the Broken Hill district in New South

Wales. The greatest producing region in South America is Bolivia. The relatively small production credited to the European countries would be still further lowered if the amounts extracted from imported ores and furnace materials, shipped there for final treatment, were eliminated.

The present output is hardly a fair index of the relative silver-producing capacities of the several countries. As much depends upon the energy with which mining is prosecuted as upon natural resources. What the latter are it is impossible to estimate. While both the United States and Mexico have doubled their output recently, this has been because of the immense amount of effort and money that have been put into the work; and while the United States still considerably exceeds Mexico in silver production, this is no proof that our silver resources are greater than those of Mexico. In South America there has been little systematic prospecting, and the older districts, worked in the early times of the Spanish occupation, have gradually declined. To make a wild guess, the silver resources of the States through which passes the great cordillera of the Andes are probably in excess of those of either the United States or Mexico. Canada is still practically unexplored, but the probability of discovering great silver mines in the Dominion is limited to the mountainous portion. It is not likely that any increase in yield will come from Europe; the geology there is pretty thoroughly understood. China possesses some silver mines, but their capacity under more efficient working is not known. Though little exploration for gold-quartz and silver ore has been done in Asia, it is likely that any important deposits accessible at the surface would have been noticed while the gold placers were being exhausted. There is no prospect of early serious competition in the silver markets from Africa.

A study of the fluctuations during long terms of years in the value of silver, increased by equal weights of gold, reveals a fair degree of steadiness during the last few centuries and until quite recent times. In the earliest historical periods silver stood much higher, in relation to gold, as was natural in view of the relative simplicity of the means which sufficed for obtaining gold, while silver, except in the comparatively rare cases where native metal was met, had to be extracted from its ores by metallurgical processes which in their most primitive forms demanded an advanced degree of skill. There were in those days wide ranges of value in different countries owing to imperfect communication. After the disturbances caused by the great influx of silver from Peru and Mexico, the ratio of the two metals settled down to a very even tenor. Toward the close of the seventeenth century the commercial ratio of silver to gold ranged between 14.83 and 15.20. In the succeeding century the extremes were 14.14 in 1760 and 15.74 in 1799. The year 1808 saw for the first time the ratio widened to more than sixteen to one (the exact figure being 16.08); and in 1818 it reached 16.25:1. Thence it remained at fifteen and a large fraction until 1874. From this date the decline has been progressive and rapid, as will be seen from the following table:

Year.	Ratio.	Year.	Ratio.
1874	16.17	1884	18.57
1875	16.56	1885	19.41
1876	17.88	1886	20.78
1877	17.22	1887	21.13
1878	17.94	1888	21.99
1879	18.40	1889	22.10
1880	18.05	1890	19.76
1881	18.16	1891	20.92
1882	18.19	1892	23.72
1883	18.64		

The average ratio for 1893 will be considerably less favorable to silver. With the price at 62 cents an ounce, which it touched in June, the commercial ratio is 33.34:1. At 70 cents it is 29.53:1.

A decline in the price of some products has a tendency to increase the output, through the attempts of the producers to maintain their net earnings by conducting operations on a larger scale. Thus a fall in prices may freeze out the weaker producers, but only stimulate the larger ones to greater activity. A notable instance of this effect is given by the copper-mining companies, of which all that were able to live have been forced to extend their operations to their highest capacity. But the conditions in silver-mining are different. It is not possible to increase the output of a given mine indefinitely, merely by putting more men and more machinery to work. As a rule, silver-bearing veins are narrow, they seldom carry ore continuously throughout their length or for great distances, and the veins generally stand at high angles,—averaging over 45°,—so that to open a mine extensively means deep mining with the added expenses of pumping and hoisting. Of the irregular contact, bedded, and "zone" occurrences of silver ore, few show very large exposures of ore bodies in any one place.

The result of this peculiarity is that no matter how well the average silver-mine may be developed—that is, opened in advance of the stopes—there is only room for a limited number of men to break down the ore, so that increasing the working force beyond a certain point would only add to the expense without a corresponding gain in output. What sense would there be in putting $20,000,000 cash into a $20,000 mine, or building a 200-ton mill for a mine supplying only 20 tons a day?

As a matter of fact, those mines which have had the advantage of a good equipment and ample capital have been worked very near to their full capacity. The whole tendency of American mining methods, in contradistinction to those of Europe, has been to push operations at the most rapid rate permitted by the means at hand and the natural conditions. In this country many a silver-mine has been worked out and abandoned in two or three years that under the old system might have lasted for centuries, though of course yielding no more metal. Increased production depends rather upon the opening of new deposits and the proper equipment of mines not yet fairly developed than upon greater activity in the mines which have hitherto been the great producers.

The purchases of silver by the United States treasury during the years 1873-92 amounted to 458,109,529 troy ounces, for which the average price was $1.0425 per ounce. The average price paid in 1873 was $1.3225, from which there was a steady decline until 1889, the average price paid in that year being $0.9356. In 1890 the treasury price reached an average of $1.0626 for the year, with a maximum of $1.20. In that year silver momentarily touched $1.21 in the New York market. The treasury price averaged $0.989 in 1891 and $0.8755 in 1892.

The average cost of producing silver cannot be stated precisely for all the American mines. It is possible to figure it out exactly for an individual mine, and to approximate the cost for a single district, but beyond this all is guesswork. My belief is that the average cost, after allowing for mining, transportation, and reduction charges, and also for depreciation of plant, sinking fund to write off original cost of mine, interest, insurance, office expenses, commissions, and other incidental expenses commonly omitted in company reports, is above the average commercial value during recent years. Indeed, considering the industry as a whole and including all the mistakes and miscalculations, all the wasted effort, all the fictitious or inflated prices paid for mining property, it is above the United States standard rate of $1.2929 per ounce. The available opinions on this subject are necessarily from an *ex parte* standpoint. Still, these come from the men who are in the best position to know, and who, beyond question, are perfectly sincere.

In a report of the Senate Committee on Mining there is much interesting testimony. Mr. James D. Hague says the cost of production per ounce on the Comstock ranged from 35 cents (in the bonanza in the height of its prosperity) to $2.10 (for non-dividend paying mines). Taking assessments into account, the average cost of all the silver produced on the lode has been $1.10 per ounce. Taking into account losses in unprofitable enterprises, ex-Senator N. P. Hill estimates the average cost of the silver produced in the United States at $1.29 and ex-Senator H. A. W. Tabor at $1.50. W. C. Wynkoop, editor of *The Mining Industry* (Denver), secured the reports of 160 incorporated companies which produced silver in 1889, and found the cost, taking the companies which did not make a profit in connection with those that did, about $1.15 per ounce. It is stated that 99 per cent. of the silver-mining claims upon which labor has been expended have produced nothing. All this work appears to be charged up to the productive mines, as regards the value of their output. The recent Silver Convention at Denver issued an address stating the cost of producing silver at $1.29 an ounce. This expression, without qualification, excited much adverse criticism. Of course it was not meant that it cost just $1.29, no more and no less. The figure was used as a round number would be, and was so understood among miners.

It has been asked, why is there such an effort to perpetuate an industry that is, according to its own advocates, unprofitable? The answer to that is that the profitable mines have had and still have to carry an enormous dead-weight of poor mining, waste, extravagance, errors, and even swindles, when it is attempted to estimate general averages for all the mines. Silver-mining, when conducted on business lines, honestly, with good judgment and skilful management, is very profitable, if the price of the product does not fall below the critical point. With silver at $1 an ounce many mines can be operated profitably. At 82 cents, where the market halted for a long time, a smaller number can live. Below that figure, very few can make both ends meet. This is proved by the recent closing of so many of the best mines. Their managers knew when they were running at a loss. The mines which have stood the strain best are those which yield gold liberally, as well as silver.

The consumption of silver in the arts in the United States has formed the subject of an inquiry prosecuted by the Mint officials. During 1892 the government assay-office at New York turned out for this purpose 5,389,943 troy ounces of silver bars, of the coinage value of $6,966,230, and the Philadelphia mint supplied 9113 ounces. Twenty-eight private refineries, believed to include all that were engaged in this manufacture in 1892, made 1,646,281 fine bars worth $2,128,525 (coinage rate) exclusive of their " U. S." bars. Altogether, the value of fine silver bars supplied to the trade from these sources in 1892 was $9,106,540, coinage rate. Of this, over $7,000,000 worth was made from domestic bullion, over $1,000,000 from foreign bullion and coin, and over $600,000 from old plate and jewelry remelted. This was a slight reduction from the corresponding total for 1891 : $9,631,740, coining value.

Thus more than one-tenth of the silver produced in this country last year went into the arts and manufactures. Counting the foreign and old material thus absorbed here, the proportion was over one-eighth as much as the total American production. There are no statistics showing the proportion of all the silver thus absorbed throughout the world. Presumably it is higher than that shown in the foregoing computation, considering the large amounts that go into plate and ornaments in the Orient. Of the silver thus utilized, the larger part never returns upon the market. Hoardings of coin and manufactured silver, especially in India and other Asiatic countries, make a steady and heavy drain upon the production. Fires, shipwrecks, loss, and ordinary wear by abrasion account for the disappearance of another portion. As the price declines, the use of silver in the arts naturally increases somewhat. But since the popularity of silver for many uses is due to its costliness, a portion of its desirability will be lost when the metal becomes cheaper.

What will become of the silver States in case silver-mining is further curtailed? It cannot possibly be brought to a full stop, for it is too closely linked with gold-mining. Ultimately these States will recover, though very slowly, and will develop their other natural resources, beginning with the exclusively gold-producing mines. The immediate effect cannot but be disastrous; the distress that has already prevailed is an index of what may be expected. A reduced production would have a beneficial effect upon the price of silver, without doubt. It will also be possible to mine and reduce silver ores more cheaply hereafter, in accordance with the general law of progress that has obtained hitherto.

A SCIENTIFIC ANALYSIS OF MONEY.

By Emil Schalk.

MONEY, like almost all other human creations, is passing through an evolution induced by new conditions of existence. Largely increased facilities of communication not only bring into play distant countries for the production of the precious metals, but also lead from local to national and international considerations. The evolution thus going on points to a single international standard as the measure of all values, and it leads inevitably to the adoption of that substance or metal which compasses the greatest value in the smallest volume, and yet is sufficiently produced to go the round of the world. Natural, organic, and irresistible conditions of trade have led to the adoption of gold as the international standard at the present time. But it is claimed by many that, if gold is legally accepted as the universal standard of value, there will not be enough of it in sight, and not enough produced, to supply all countries with a gold currency. There is no doubt a great deal of truth in that assertion, but it applies equally to any other metal.

To solve the money problem, the question needs to be treated from a more scientific standpoint than heretofore. The devising of a system of weights and measures (and money forms part of any such system) is considered a scientific matter of the greatest importance, and is invariably referred to scientific commissions charged with carrying out the task. When France adopted her metric system, which is at the same time the simplest and yet the most scientific in existence, the commission which devised it was composed of the greatest mathematicians and astronomers of France. They established a unit of length which was called the meter, and subdivided it on the decimal plan. This meter forms the basis of all measures of surface, volume, weights, and values. A decimeter cube is called the liter, and is the unit for volumes, and the weight of a decimeter cube of distilled water at four degrees Celsius, and at an atmospheric pressure of 76 centimeters of mercury, is called the kilogram, and forms the unit of weight. The same unit of lineal dimensions was made the basis of the measure or unit of value. The gram is the weight of a centimeter cube of distilled water, and the unit of value was fixed at five grams of silver nine-tenths fine, and it was called the Franc. The law which introduced this comprehensive system of weights and measures dates from 1801, and at that time silver was the favorite metal for money purposes, and almost all nations used it as the standard of values.

In the establishment of weights and measures, the difference between unit and standard ought to be thoroughly understood. With lineal measures but one quality is required,—that of length. For weight two qualities are required,—lineal dimensions and weight of the substance to be used as standard. There are no two substances which for the same volume have exactly the same weight. Consequently some substance has to be selected as the standard or unit for comparison. The French have adopted distilled water, at 4° Celsius, etc., as the standard, and it is so considered to-day by all civilized nations. It is the standard of comparison for the weights of all other substances on the face of the earth, and the weights thus expressed are called specific gravities and are tabulated in all scientific works.

When we come to the measure of values, we find that, besides the two qualities of lineal dimensions and weight of the substance, a third quality is required,—that of value. But by comparison of all substances with the one selected as standard a specific value is created for all those substances, exactly the same as a specific gravity. For instance, the ratio of gold to silver, gold being the standard, is like one to twenty, meaning that it takes twenty times the weight of silver to make up the value of one unit of gold. Hence it is easy to see that in a scientific money system there can be but one standard of value, just as there can be but one standard of weight. A double standard of value is just as unscientific and absurd as would be a double standard of weight.

Once a unit is fully established, it follows logically that it can be indefinitely reproduced. From the standard meter made of platinum hundreds and thousands of meters can be reproduced in all kind of material, and serve for all the daily uses of commerce and trade. In the same manner, from the standard kilogram of distilled water the same weight can be reproduced, and in any kinds of material that may be desired. The only condition is that all the reproductions must have the essential quality of the established unit and standard. The meter which is reproduced must measure exactly a meter, and the kilogram must weigh a kilogram. This characteristic of all weights and measures applies equally to the measure of value, and in the application of this simple principle to money is to be found the solution of the whole problem. The unit and standard of value, once established, will serve to measure all other substances of value, and they in their turn may be made the basis of additional measures of value or money, up to the limit of all possible requirements.

In establishing a standard for weights, no difficulty is experienced as regards fluctuation in the weight of the chosen substance. The difference in weight between distilled water and all other substances is a fixed quantity in nature. But with a standard of value it is different. Value exists only in the mind of man. It depends on the object being more or less needed, more or less desired; it depends on demand and supply, on whims, fashions, and sometimes on ridiculous notions, as for instance the value of tulips a couple of centuries ago during the tulip craze in Holland. It is not to be wondered at, therefore, that standards of value have greatly varied at different times and in various countries. In Homer's time cattle and sheep formed the standard. Later on iron, copper, silver, and gold were used for the same purpose. As civilization progressed, the substances most valuable in the estimation of mankind naturally were adopted as standards; and at the present time the phenomenal improvements in the facilities of communication, the vast amount of travel, the vastly increased commerce of the world, with the necessity for settling balances of trade between nations, has led to the employment of gold as most suitable for the purpose and as having the greatest value to the smallest volume, with the least fluctuation in its value. A century ago Alexander Hamilton, in his report on the establishment of a mint, said: "As long as gold, either from its intrinsic superiority as a metal, from its rarity, or from the prejudice of mankind, retains so considerable a premium in value over silver as it has hitherto had, a natural consequence of this seems to be that its condition will be more stationary. The revolution therefore which may take place in the comparative value of gold and silver will be changes in the state of the latter rather than in that of the former." This prophecy has been justified by events. Gold has evolved naturally and irresistibly into the one international standard of value.

Most countries have a unit of value of their own, which consists of a piece of coined money differently denominated, but representing a fixed weight of the substance chosen as the standard of all values. Among all nations, civilized or half-civilized, either gold or silver is the standard; and as far as the international relations are concerned gold alone serves as the standard. The dollar, the franc, the mark, pound sterling, ruble, etc., are the names of the units adopted in the United States, France, Germany, England, and Russia respectively. Each of these denominations of money is the unit of value in its respective country, and it goes without saying that each country has but one unit. But the value of all these units in the world's commerce is determined by the weight of gold which each is supposed to represent.

To be the measure of value, the material used for money purposes must have an intrinsic value. In itself it must be valuable property, entirely aside from being made legal tender by law. Being valuable property, and at the same time the measure of value, it becomes the generally accepted medium of exchange. The essential idea of barter is that valuable property is exchanged for other valuable property, of a different kind. By the use of money one side of the barter is always money; and as it is exchanged for other property which is measured by it, it must be as good property, in exchangeable value at least, as its face value claims to be. It must be part of the actual wealth of the nation to which it belongs. As a measure of value it is of use only for measuring other property; and as a piece of value it is of no use except for the purpose of exchange. By itself it does not feed, or clothe, or lodge, nor does it bring any income; and yet it is the synonym of all wishes. It is these peculiarities which render money a powerful factor in the progress of civilization. Without money, or with very little of it, exchanges become slow, trade and manufacture seem paralyzed, wages decline, and interest is very high: it means stagnation. Too much money, on the other hand, will stimulate exchanges to excess, advance wages and the cost of production, unduly depress interest, and overproduction and inflation will be the consequence. There must be a "*juste milieu.*" So far this *juste milieu* has not been scientifically established.

The general way of computing the amount of money necessary is to compare the amount of money per capita of each country, which, however, is very misleading. According to this method the circulation of the principal countries is as follows: France, $41.50; Holland, $28.50; United States, $25; England, $20; Germany, $19.50; Spain, $19; Italy, $11; Austria, $9; Russia, $5.

According to this list, England, Germany, and Spain have about the same amount of money per capita, yet the wealth and commerce and general conditions of the three countries are widely different. A more correct way, at least in the sense of the present inquiry, would be to ascertain the amount of money in the percentage of the general wealth, though this method is also very misleading, as will be seen from the following figures showing the approximate proportions of money, or property used for the mere purpose of exchange, to the rest of property. Thus France has 1 unit of money to 27 units of property measured by the money unit; Spain has 1 to 31; Germany 1 to 33; Holland and the United States, 1 to 40; Russia and Italy, 1 to 42; Austria, 1 to 51; England, 1 to 60. We find here France and Spain, and Austria and England, side by side, yet the wealth, commerce, and banking facilities of those countries are widely different, so that no general conclusion as to the proper amount can be drawn from these figures.

Every country must have a proper supply of money, and it ought to be regulated according to its needs, and not be left to blind chance, such for instance as free coinage implies. But where is the money to come from? The standard ought to be a metal, and we see that the present imperative demand is for gold. How is a country to obtain the necessary amount of gold for its monetary system? There are countries which produce the precious metals, and there are others which do not. There are countries which have large manufacturing interests, and large exports, and which in course of time have become creditor nations, and are able to command gold payments. The great creditor nations have no difficulty in eventually getting all the gold they want, even if they do not produce the precious metals themselves. But debtor nations are apt to lose their gold, even if they are large producers of it. They are obliged, according to their trade balances, to pay in the precious metals which they have mined. It is an easy matter for creditor nations to establish the gold standard and to maintain a gold currency. It may be a possibility for gold-producing countries, though debtor nations, to do the same, but the question looks different for all other countries. For those the question arises, how to obtain the gold, and, when they have it, how to keep it? This problem troubles even the creditor nations, for their wealth to some extent depends on the ability of the debtor nations to pay and to keep on paying.

The solution of all the confusing difficulties is to be found in the logical application of the scientific principles defined in the first part of this article. Money is the measure of value, and once the unit and standard are established, can be indefinitely reproduced precisely as can all weights and measures. Nobody, for instance, would think of using the platinum meter, the standard meter of France, for measuring a piece of cloth ; nor would any one think of using a decimeter cube of distilled water as a means of weighing a kilogram of butter. Reproductions of those weights and measures, in wood or iron, or other material, and properly certified by the government to be correct, are used. And in the same manner, after the establishment of a unit and standard of value, there is in most cases no necessity for using the actual gold for barter or exchange. The wealth of any country will furnish innumerable objects which may be made the basis of money after being properly measured by the standard. Reproduction here is as natural as with the other weights and measures. In fact, part of the wealth of every country ought to be in that peculiar "fluid" shape of property called "money," the stimulus of all commerce.

Naturally this will lead to paper currency, in addition to the metallic, for the reason that comparatively few objects of wealth are directly capable of being sub-divided into units and stamped as correct. But such paper currency will differ from other paper currency in so far as it *represents valuable property, is the title thereto, and not a mere promise to pay.*

This will be the natural solution of the money problem, and it is the trend of evolution in the near future. In Europe several railroads have been built by means of money issues secured by the property of those roads. Here we have made a commencement by requiring the national banks to keep with the government a deposit of valuable property to the full value of their issues.

To bring about a lasting solution of the money question, at least in this country, a commission of scientific men and experts in finance ought to be appointed, to whom the whole question should be submitted for deliberate and exhaustive inquiry, and from whom a disinterested, scientific, authoritative, and practicable system may be expected. We need to follow that example which has given to France a system of weights and measures so scientifically faultless that it is destined ultimately to be universally adopted. We need, in short, the research and guidance of a body of able, distinguished, and non-partisan scientists, who will lift our whole currency system to a high plane of exact and practical science, and forever divorce the business of finance from the business of politics.

THE REAL CONDITION OF THE FARMER.

By George E. Roberts.

THE condition of the farmer in the United States, particularly in the western part of the country, has become a conspicuous subject of discussion in recent years. His mortgages, his alliances, his railway tariff-sheets, and his relations to the various political issues have been fruitful themes for economists of all grades of ability and all degrees of information. This discussion has extended to other countries, where his cheap products have been forcing a readjustment of land values and rents. Across the Atlantic people want to know whether the American farmer can continue to live and keep up this pressure of products at prices which make past rentals out of the question. And we want to know here, in these times of financial uneasiness more than ever before, the true condition of this army of wealth-producers, whose thrift is the basis of the nation's prosperity, and whose contentment is security against all alarms. Are their debts increasing, or their ability to pay diminishing? Are they falling behind financially, or are they gaining in wealth and sharing in the benefits of progress?

The farmer is not, generally, a good witness for his own prosperity. It is common for men to overrate the opportunities of other callings as compared with their own, and to unduly emphasize the hardships, or difficulties, and lack of compensation, in their own pursuits. Each is far more familiar with the drawbacks to his own business than with those which belong to others. Perhaps this is especially true of the farmer. He sees less than those who live in cities of the margins, risks, struggles, and failures of trade. His isolation serves as the distance which lends enchantment to the view. He knows that he works hard, longer hours than most other men, and that his accumulations come slowly. Whether or not a man's lot is satisfactory to himself depends chiefly on whose lot he compares it with, and the farmer too often compares his sure but small average gains with the exceptional successes in other occupations.

The rewards of business are governed by certain conditions which apply alike to farming and other occupations. We do not expect large margins in producing or handling any staple goods for which there is always a large and ready market, or in any line of business in which competition is not somewhat restricted by the need of capital or special training. It would be contrary to the common law of competition and profits, if the profits of any business did not decline as hazard, capital, and skill were eliminated from it. I do not argue that no hazard attaches to farming, or that no capital or skill are employed in it. I wish to show, however, that the annual earnings of the farmer have been affected by the general law of compensation which in the long run takes account of all advantages and disadvantages and gives rewards accordingly. It is the western farmer, the grower of the great export staples, who has been the chief figure in this discussion, and, if we are to measure his compensation by the general rule, we must know what hazard his investment has stood and what inducements there have been for competitors to go into business alongside of him.

The first concern of every prudent investor is not for his profits, but for his principal. Where that is absolutely secure we expect the annual return to be less. Capital seeks investment where it can yield part of the ordinary return in exchange for exceptional security. Now, if there is an investment which is not only secure, but which will increase in value independent of profits, and by forces outside of its owner, it is to be expected that investors will be attracted to it, and that the *annual* earnings therefrom will be reduced. These western farms have been investments of that kind. The manufacturer who equipped his factory thirty years ago has discarded and charged to profit and loss his entire original capital by this time. The merchant who opened a store thirty years ago has lost the amount of his capital in depreciation and bad debts. Their annual profits needed to be large enough to make good this shrinkage, but the man who opened a farm in Iowa or Illinois thirty years ago has had no shrinkage in the value of his land to make good. On the contrary, if he has done nothing more than get a living from its annual return, its increased value will keep him through old age. The man who claims that farming in these western States "does not pay" always argues that the rise in the value of land is not to be counted as part of the earnings of the business. But any consideration which is sufficient to attract competition into an occupation thereby reduces its other earnings and must itself be credited instead.

Cheaper railway rates have levelled down in some of the older parts of the country as they have levelled up in the west. But in all of that region which has been settled in the past thirty years, and whence come our grain exports, there has been a large advance in the value of land, and the certainty that such advance would come has been a factor in its development and in the resulting price of farm products. The history of Ohio, Indiana, and Illinois was a guaranty that a good homestead entry of 160 acres west of the Mississippi would within a lifetime be worth more than the average life-savings of a mechanic or laborer. And so these cheap lands filled up, not simply for the annual profits of the farm, but to secure the rise,—the "unearned increment." Twenty years ago Edward Eggleston put the sentiment of the times as to land into the mouth of one of his Hoosier characters when she said, "Git a plenty, while yer gittin." That has been the policy; not to take a small farm and cultivate it highly, but to spread over as much land as possible, by the aid of modern machinery, raising the few staples which would bring quick returns, and mortgaging all that could be paid for to buy more while it was cheap.

The United States census of 1860 called attention to the rapid advance in the value of lands which was following the opening of new railroads. Here is an extract from the census report:

> The influence of railroads on the value of farming lands is too great and striking not to have been noticed by all intelligent persons. We have, for example, the immediate effect produced on the lands of Illinois by the Illinois Central railroad. That company received from the government a large body of land at a time when the government could not sell it at $1.25 per acre. Since then the company has constructed its road and sold a large part of those lands at an average price of $11 per acre, and the greater part of the lands of Illinois are worth fully that. Notwithstanding the rapid growth of population, the larger part of this advance is due to railroads. The following table shows the advance (by the census tables) of the cash value of farms in the five States mentioned, in the ten years, 1850 to 1860:

	1850.	1860.
Ohio	$358,758,602	$666,564,171
Illinois	96,133,290	432,531,072
Indiana	136,385,173	344,902,776
Michigan	51,872,446	163,279,087
Wisconsin	28,528,563	131,117,082
Total	$671,678,074	$1,738,394,188

> We need not pursue this subject further. If the effect on the central western States has been so great, it is still greater in the States which lie beyond the Mississippi. They are still farther from market, and will be enriched in a greater ratio by the facilities of transportation.

At the time this was written not a mile of railway existed within the boundaries of the present States of Minnesota, North Dakota, South Dakota, Nebraska, and Kansas, and only 655 miles in Iowa. In 1890 there were 32,988 miles in these States (more than the total mileage in the United States in 1860), and the history of rapid development and advancing land values in the central western States, as prophesied in 1860, had been outdone.

With this security for investment and assurance of increased value in the future, is it to be wondered at that the stimulus given to farming resulted in low *annual* earnings? We have eliminated risk from the investment; now let us see how small was the investment needed, and how little the training or the skill involved, in opening a prairie homestead and producing a crop of grain There is ample room for skill and management in farming, but the farming which has filled our markets with wheat, corn, and oats has been done by main strength, and the price of these grains has tended downward to that measure of pay.

We threw open our gates to the whole world, offering a homestead to every family that would occupy it. The railroad companies flooded Europe with agents inviting settlers, and millions of industrious people accepted the invitation. The number of acres of improved land in Iowa, Minnesota, Kansas, Nebraska, and the Dakotas increased from 4,875,414 to 44,507,915 between 1860 and 1880. The people came not so much for the immediate returns from these farms as to get homes. Their reasonable expectations have generally been more than realized, although there have been many years when the enormous production thus stimulated has made the prices of products discouragingly low. Is this not what might have been expected?

The census reports show how the production of the staples of these States has increased faster than the population of the country. These figures give the total production of grain in the United States to each inhabitant of the country, for the years named:

	1849.	1859.	1869.	1879.
All grains, bushels...	37.32	39.41	38.57	53.79

The great increase was between 1869 and 1879, the period of greatest depression of prices. The census reports for 1890 have not been completed, but it is known that the gain of products upon population has ceased. The cheap lands are gone. The period of artificial stimulation has passed. The man with only a team of horses and a plow as capital can no longer open a new farm. This change in conditions may bring other problems, but the condition of the man who owns 160 acres of good farming land in this country will soon cease to disturb anybody but the single-taxers. I do not wish to convey the idea that no money has been made in farming except by advance in land-values, but to show that those who did the plain work of raising grain in competition with free lands could scarcely expect different results. But all over the prairies the improvements upon farms, new houses, larger barns, growing herds, are visible evidences of the steady accumulation of wealth.

Against the showing of homes secured and wealth created in farm values, there can be but one offset to sustain the claim that these western farmers have not prospered. That is their indebtedness. Are they secure in these homes? Has this increase in land values inured to their benefit, or is it offset by mortgages made to pay living expenses? Some people regard all debt as an unmixed evil, and in estimating the prosperity of a community they treat the mortgage as the most significant and conclusive fact to be considered. But every one familiar with growing cities or a new country knows that a mortgage does not necessarily mean that the maker is becoming poorer. Almost all of the farms in the western States are owned by men who began life upon them with small means. They obtained possession by small cash payments, giving mortgages for the balance. Even in the older States the passing of property from the elderly and well-to-do to the young and ambitious gives continual occasion for the same class of mortgages.

Wherever values are advancing it is the common practice of investors not to avoid mortgages but to make them as large as possible and spread their ready money over as much land as possible. The man who has enough cash to buy 80 acres and own it free of debt, in times of prosperity prefers to buy 160 acres and give a mortgage for half the sum. These people who argue from mortgages alone would use the latter case to prove that the man was in distress, whereas it was his confidence in his own and the general prosperity which occasioned the mortgage. Chicago has been one of the most prosperous cities in the world. The owners of real estate there have been among the luckiest people, and yet from 1880 to 1889 the mortgage debt incurred in Cook county increased five-fold. In 1890 that indebtedness in Cook county was $161 per capita, while for the rest of the State it was only $73. The increase in population in Cook county during the last decade was 97.19 per cent., against a general increase of 24.86 for the whole country. St. Louis presents the contrast of a city whose growth has been only slightly greater than that of the whole country, the

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percentage during the decade being 28.89. Its mortgage indebtedness in 1890 was $91 per capita, or but little more than one-half that of Chicago. It cannot be concluded from this fact that St. Louis has been more prosperous than Chicago, but that is the logic of the hue and cry about farm mortgages.

The men who began on farms without capital were obliged to do without equipment and improvements very desirable to have, and which they strive to get as early as possible. Most of them began without shelter for either crop or live stock and very poor shelter for their families. As they prosper they prefer to make these improvements rather than pay the mortgage. Or, as the boys grow up, and they see land advancing in value, they want the piece that joins them. So the mortgage stands, or is replaced with a new one drawing 6 or 7 per cent. interest, instead of 10 per cent. This mortgage signifies investment, not distress.

The last census embraced an exhaustive inquiry into the subject of farm mortgages, the result completely disposing of the theory that they are made to pay losses in farming operations. Here is a summary of the census report for Crawford county, Iowa, which is a fair sample of the general showing on the subject :

OBJECT OF INDEBTEDNESS.	Per cent. of total amount.
Purchase money	64.11
Improvements	10.29
Purchase and improvements	9.61
Improvements and farm stock	1.87
To buy more land	1.87
Outside business	4.45
Farm expenses and property	2.88
Farm and family expenses	1.12
Purchase, farm expenses, and property	.97
Purchase and other objects	.50
Improvement and other objects	.46
All other objects	1.87
	100 00

The detailed report is more convincing than the summary, as it shows more particularly the cause of the small percentage of mortgages which stand for home and farm expenses. Sickness and death in their families, loss of crops by storms, epidemics among live stock, and similar misfortunes, coming upon men without reserve means, account for a good proportion of these. From 2 to 5 per cent. covers the proportion of mortgages given to make up farm and family expenses in the States having a greatest showing of mortgages. It is doubtful whether any other line of business can give a more satisfactory account of its debts.

The newer States show a larger percentage of mortgaged land than the older ones. In the table herewith are presented some comparative facts regarding farm mortgages in four prairie States, with the date of the creation of each State. The table shows:

I.—Percentage of total number of acres under mortgage.
II.—Average mortgage indebtedness per mortgaged acre.
III.—Estimated average value of all farm lands.
IV.—Percentage of partial payments upon mortgages at the date of the census.
V.—The average life, in years, of a farm mortgage.

STATES.	I	II.	III.	IV.	V.
Illinois (1818) ...	30 78	$15.50	$35.95	11.71	4.0
Iowa (1846).....	46.95	9.17	23.96	12.25	4.9
Nebraska (1867)..	58.13	6 43	14.45(a)	5.21	3.2
Kansas (1861)....	61 56	6.57	13.83(a)	5 00	3.3

a. The averages of value in Nebraska and Kansas are much reduced by the large areas of low-valued lands in the western halves of those States.

The last column in this table does not signify that farms have been cleared of debt by this time, for there is a constant shifting as better rates of interest or other considerations induce. The partial payments usually are made from farm earnings. They should be considered in connection with the average life of the mortgages, but they fall far short of showing the surplus earnings, because there is a constant investment of surplus in betterments.

It would help to a knowledge of the condition of a State to know where its mortgage indebtedness is held, but the census bureau found this difficult to arrive at. In four Kansas counties it was found that about 45 per cent. of the mortgages ran to residents of the State, excluding mortgage companies and loan agents, and the commissioner believes this a fair basis to judge the State from. In the older States undoubtedly a much larger proportion of the money borrowed is supplied by residents. The Auditor of State for Iowa estimates that 75 per cent. of the deposits of the State banks, which are under his supervision, belong to farmers. If he is correct, the bank deposits of farmers in Iowa, including national banks, are sufficient to pay all of the mortgages on Iowa farms. At a valuation of $77 per head the horses on Iowa farms would pay the entire farm mortgage debt.

To one who knows anything of the risks and anxieties of trade, the constantly narrowing margin of profits, and the pressure of competition, there is a security and certainty in the farmer's position which deserves to be more highly valued than it is by many who possess it. House rent and food the farmers have as a matter of course, and they scarcely think to give the farm credit for it. If times are hard, the outgo can be made exceedingly light. If well farmed, the land must increase in value, now that the arable parts of this country are so fully occupied. The population increases rapidly. Improved methods of culture will constantly increase the yield of a given acreage, and perhaps so rapidly that prices may not rise, but either in an increased product or an increased price the restricted acreage must effect better results for the farmer.

The productive capacity of each farm-laborer increases annually by the aid of labor saving machinery, while the cost of farm- and living-supplies is decreased by the constant fall in prices of manufactured goods. One man riding a self-binding harvester, which now costs in Iowa $125, does as much work in a wheat-field as six men with a machine which cost more money could do twenty-five years ago. The prices of farm products at this writing are depressed by a period of extraordinary financial stringency, but there has been no such continuous decline as in manufactured goods. There has been no decline that is not accounted for by an increased supply. The average of Chicago prices on corn, oats, and wheat for the past decade is but slightly under the average from 1870 to 1880, or even from 1860 to 1870, if these are reduced to a gold basis. In the far west, where drouth makes crops uncertain, the farmer is of course taxed with risks for which he gets no compensation, unless it be in cheaper land, for he must sell his products in the common market. But in the region of sure crops the farmers as a class are the safest people in the world to do business with, to sell goods to, or to loan money to. No other class of people buy or borrow so little in proportion to their means. Their products may at times be low in price, but they can always be turned into money, they always swing back to a fair price, and they do not go out of style. The country districts where banking and merchandising are based immediately upon agriculture have been comparatively tranquil throughout the excitement of the past three months. Continued hard times elsewhere will affect them, but the market is world-wide, and the allowance for food the last to be reduced.

There always has been, and there still is, a great deal of hard work about farming. Its isolation, the consequent absence of social pleasures, the lack of stimulus to mental culture, and lack of time for it, have always been pathetic features not to be ignored. They have sent the ambitious boys to the cities in droves, and made life a dreary round of drudgery to many women. But the conditions of life in this respect are improving. The creameries have taken the butter-making out of the farm-house, and machinery has dispensed with the drove of harvest hands that formerly had to be fed with the help of the farmer's wife. The cottage-organ, the spring-wagon, and the top-buggy are now to be found on farms everywhere, and they signify more thought for comfort and easier circumstances than of old. The district and graded schools are much better than formerly.

We can only guess what telephones and electricity may do to break down the isolation which has been an unfortunate feature of farm-life, but we can imagine much. Strange as it may seem, the greatest discouragement to the farmers in recent years has been the difficulty in getting trustworthy help. There has been a great scarcity of men and women to work on the farms and in the farm homes. The reason is that they crave the excitement of city life.

One of the representative farmers of Iowa is the Hon. L. S. Coffin, of Webster county. He has been a member of the State Board of Railroad Commissioners, and connected at one time or another in an official capacity with the several State agricultural organizations. He recently furnished a reply to a series of inquiries from the Senate Committee on Agriculture, from which I have been permitted to copy the following paragraph:

> All my life I have been a farmer; came to Iowa empty-handed; am now well-to-do; have a large beautiful farm of 720 acres; well stocked with full-blood cattle, hogs, and sheep; out of debt; borrowed some money to start with after I had opened my first quarter-section; am now seventy years old. There is no general avocation in this State that is so sure of good fair returns as farming. My best judgment is that nine out of ten of the well-to do farmers of this State commenced life as I did,—as a hired hand. . . . My opinion is formed from long and close relations and observations that in this State not less than 95 per cent. of our farmers make a success of farming, and in the end find themselves well fixed for old age, and to-day, with the uncertainty spoken of above as an exception, we never were so prosperous as an agricultural State as now.

Such testimony could be so abundantly produced as to completely overwhelm the pessimistic views spread abroad by people who as a rule have theories to support or axes to grind,—and are devoted to these purposes rather than to the welfare of the farmers.

THE FALLACY OF MUNICIPAL OWNERSHIP.

By M. J. Francisco.

THE subject of municipal ownership of lighting plants is at the present time attracting widespread attention. Statements favoring such control have been made, in which serious errors appear, calculated to mislead the public in regard to the cost of electric lighting. These statements have been made by parties whose interests—and in many cases their positions—have depended upon a favorable report of the cost of the lights. Nothing is easier than to make the claim that municipalities can and do furnish lights at lower rates than private companies, but no attempt is made to prove the assertion, and mere words are not evidence. Not an instance can be shown where municipalities have furnished the lights at a less cost than private companies, if all the expenses are considered and the facts are candidly stated.

There are many intelligent men who are opposed to the scheme, because of the political dangers to the nation and State and to municipalities themselves in this attempt to control private industries. No sober-minded citizen can fail to recognize and admit the objections to the plan, and no one will pretend for a moment that it is not surrounded by grave difficulties and uncertainties. Consider for a moment the effect if all the capital and employés of the railroads, telegraph, telephone, and electric-light companies were placed under government ownership and control. Not only would an indebtedness be created almost beyond the limits of computation, but an army of employés whose magnitude would dwarf the combined military forces of the world would be added to the political machine. Even the strongest advocates of municipal ownership must admit the danger of such an army of employés subject to the manipulation and control of any political party. The principle advocated in municipal control is the same as in national control, only upon a smaller scale, and the result can be traced even in insignificant municipalities where it has been tried.

Private companies are not paid a proper price for lights at the present time, as is shown conclusively by the fact that thirty-three of fifty-six electric-lighting companies doing business in Massachusetts could not pay any dividend, while the average dividend paid in one year by the whole fifty-six companies was only .0235 per cent. If private companies, with all their skill and close business management, can barely pay expenses at present prices, how can a municipality be benefited by engaging in the business, while relying for service and information upon politicians and municipal managers lacking experience and changed at every election? Even where the officials are honest in the performance of their duty, they are, in the words of ex-Mayor Hewitt, "constrained and overruled and compelled to reward political service by public office."

It is conceded by all who have had experience that an electric plant requires the most careful attention and all the skill and sagacity that can be secured to make it a success, even when conducted by men who are financially interested in it, who feel in their pocket the cost of every expenditure, and whose entire fortune may depend upon its successful management. It is admitted that a man pays closer attention to business details and economy where he has the most at risk. In all municipal enterprises there is a lack of attention to mechanical and other details which must be carefully watched and guarded in order to insure success. No sane or fair-minded man will, with the corruption and fraud practiced by politicians at the present day, attempt to prove that it is for the best interest of the taxpayer to place faith in the honest or conservative management of any enterprise which can be manipulated in the political arena for the advancement of the men in power. Human nature is the same the world over and will be forever. The best guide of what the future has in store is a comparison and study of the past. The histories of New York, Philadelphia, and many other cities are samples of what will be done for political preferment. In every case the records show that it has been for the best interest of the citizen and taxpayer to contract with an electric-light company for lighting streets.

Where a municipality owns the plant there are many ways by which the cost can be reduced apparently besides the practice of true economy. Officials see no necessity of inaugurating strict business methods when a plausible statement that there is a reduction satisfies the public. The cost of lights under municipal ownership is not always correctly reported to the committees and city officials who are investigating the subject. An examination of the reports given to representatives of Mobile, Scranton, Milwaukee, and Steubenville, by the authorities at Little Rock, Chicago, Ypsilanti, and Aurora, shows that no two reports from the same place agree.

The authorities at Ypsilanti reported to the committee from Mobile that the cost of their lights was $33 79; to the committee from Scranton that it was $23:61; and to the committee from Milwaukee, $37. Then the Steubenville committee were informed that the cost was $40, and in the last report to the mayor of Watertown they state it costs $46 per lamp per year, or double the cost reported to the Scranton committee. The same variations are found in reports from other cities owning plants. If the records and accounts are properly kept, why do not these reports agree? The advocates of municipal ownership claim that the city of Philadelphia is making money on its gas-plant, but the committee sent there by the Massachusetts legislature made an investigation and reported that Philadelphia was losing $106,144.26 per year in running her municipal plant. The folly of small cities loading themselves down with debt to install a municipal plant has been illustrated time and again. In addition to the tax to be levied for the payment of interest and principal, there is the annual expense of running the plant and repairs to be made, thus placing a burden upon its citizens which cannot be overcome in years, besides driving would-be citizens away on account of the heavy taxes caused by these debts and expenses.

Many cities have been induced to adopt municipal ownership under false impressions. Their councilmen were deceived by the statements regarding the cost, supposing the figures furnished by municipalities owning plants to cover all the charges. After adopting the plan they found that electric lights could not be run as successfully or as cheaply under municipal control as when furnished by private companies. They are, therefore, trying to unload with as little loss as possible. In illustration of this the experience of Greenville, Carrollton, Hope, Stockton, Lyons, Marcaline, Michigan City, and Portland, which have tried and abandoned municipal ownership, may be cited.

In the list of cities quoted by the advocates of municipal ownership, the price per year in a place using water-power and only running twenty nights a month, until midnight, is compared with the price of private companies using steam-power and burning all night and every night in the year. Then the reason given for the difference in price is that in one city the municipality owns the plant and in the other it is furnished by a private company. The liability that a city assumes when it owns a plant is never included in the estimate, and the armatures destroyed are not reported as an expense or loss; neither are the accidents reported, though in many cases these may cost thousands of dollars.

An investigation of twenty-nine city-owned plants shows that the average cost per hour is 0.564 and the average candle-power per hour for 1 cent is 361. A like comparison of 29 private plants furnishing lights under contract shows that the cost averages .0374 per hour, and the candle-power per hour for 1 cent is 576. This investigation shows that in nearly every case the cost per hour, where a contract is made with a private company, is less than when light is furnished by the municipality; also that the candle-power for one cent furnished by the private company is more than that produced by the municipal plant.

Reports from a large proportion of the municipal electric-lighting plants in the United States demonstrate that the average cost per lamp per year is $116.46, while the average candle-power per hour furnished for 1 cent is 402. Like reports from 1000 electric-light companies, embracing both steam- and water-power plants, and furnishing lights under contract, show that the average price per lamp is $100, the average cost per hour .0357, and the average candle-power per hour furnished for 1 cent, 560. By a comparison of these two classes of reports it will be seen that the average price under municipal ownership is $16.46 per lamp more than it is where contract is made with a private company; also that the candle-power per hour furnished for 1 cent is 158 less when furnished by municipalities than when private companies are producing the lights. In the reports of cost of lights where the municipality own the plant all of the expenses are not given, and in many cases part of the expense is charged to other departments and no allowance is made for interest, depreciation, taxes, or insurance, though these are items that practically affect the taxpayer as much as the bills for coal.

The municipal plant at Allegheny, Pennsylvania, suffered a loss by fire, and, when the insurance was paid, the city officials deducted the amount paid by the insurance companies from the running expenses, claiming that the balance was the cost of running the lights. The query arises: if this plan is adopted, how long will the buildings last, and must they burn one every year to make the expenses correspond with the present report? Danville, Virginia, lost an armature costing $500, and then the station burned, and there was a loss of $9000, as the property was not insured. Can you find any reference to these losses in the reports that are being circulated regarding cost of lights in Danville? Yet they are part of the cost to the taxpayers. In Bay City, Michigan, a report was made to the taxpayers, in which it was shown that the expenses of 150 lamps for one year was $11,683.03. They also stated in the same report that "the actual cost of a light for one year was $46 20,"—that is, under municipal ownership, when you divide $11,683.03 total expense by 150,—number of lamps,—the quotient is $46.20! This is a sample of municipal bookkeeping.

Danvers, Massachusetts, has been cited as an example of the success of municipal ownership. Upon an examination of the town report we find the lights are only run 1500 hours per year, cost .0568 per hour, and only furnish 211 candle-power per hour for 1 cent. The expense of the legislative committee, amounting to $1635.84, is charged to construction; how much can the town realize from this item as an asset? Easton, Pennsylvania, is another city where municipal ownership has been tried. The mayor in his last message said: "In Easton the cost is claimed not to be over $87 per year, but both the city treasurer and controller, who are familiar with the subject, claim that the cost is far in excess of these figures, and may reach the highest figures of any city which owns its own plant." An examination of their business demonstrates that the cost is $147.22 per lamp per year, and .0457 per hour, only furnishing 437 candle-power per hour for 1 cent.

In an article in the *Review of Reviews*, Hannibal, Missouri, was cited as affording an instance where the benefits of municipal ownership were apparent. They had a cyclone which damaged the station badly, and the repairs cost $711.88. Instead of charging this to repairs, where it belonged, they charged it to construction account. In this way taxpayers were led to believe that they had improved the building that much, whereas they had only repaired the damage caused by the cyclone. Clearly the money thus expended was a loss, and should have appeared in the loss or expense account. They have burned out five armatures, and the claim is made that these were destroyed through ignorance and carelessness, but this must be expected where management is controlled by the results of an election.

Referring to the table given in the article in the *Review of Reviews*, we find, under the heading of prices paid to private companies by cities for lights, that Sedalia, Missouri, running on "moon schedule," the same as Hannibal, is furnished 2000 candle-power lamps for $87 per year, the cost being .0397 per hour, giving 564 candle-power per hour for 1 cent. Thus it will be seen by their own table, where they give the price of private companies, that Sedalia is receiving 134 candle-power more per hour and at a cost of .0143 less per hour than Hannibal, after crediting the latter place with the income they receive of $4000.

In Marietta, Ohio, the lights produced by the municipal plant cost .0589 per hour, furnishing 339 candle-power per hour for 1 cent. The city superintendent also has charge of city buildings, prison, and fire-department, and his wages are charged to those departments; the city prisoners are also used for handling coal. Parkersburg, West Virginia,—only twelve miles from Marietta,—is supplied with lights by a private company for .0265 per hour, being .0324 per hour less than it costs Marietta. In addition, Parkersburg receives 754 candle-power per hour for 1 cent, getting more than double the light that Marietta does, at less cost.

Peabody, Massachusetts, established a plant, and in four months' time discovered how $12,107.43 (the expenses) could be divided by 146 (number of lights) and show a yearly cost of lamps of only $68.72. This system of mathematics will work successfully only under municipal ownership. In their assets are included $1500 paid for court expenses, and $500 expenses before legislative committee. In addition, there are salaries, attorney's fees, rent, and other items of expense, amounting to $3752, charged as assets, but which belong in expense account.

Can any one produce a statement showing the cost of municipal lights in Topeka, Kansas, that includes twelve armatures they have destroyed, costing $4800? Ypsilanti, Michigan, in 1890 had running expenses of $2500; now they are $3800, and steadily increasing. The authorities were asked if, with their experience, they favored cities doing their own lighting. They answered "no," for political preferences and frequent changes of management are too expensive,—incompetent engineers, linemen, and trimmers are kept in place by a committee for political or other purposes; and poor carbons, lack of attention generally, grounding of wires, breaking of globes, and constant repairs, make this system expensive and the cost an unknown amount until the year expires. All kinds of complaints and no responsible head is the rule.

This is municipal ownership, the new political machine of the nineteenth century.

STEAMBOATING IN THE WEST AND SOUTH.

By Walker Kennedy.

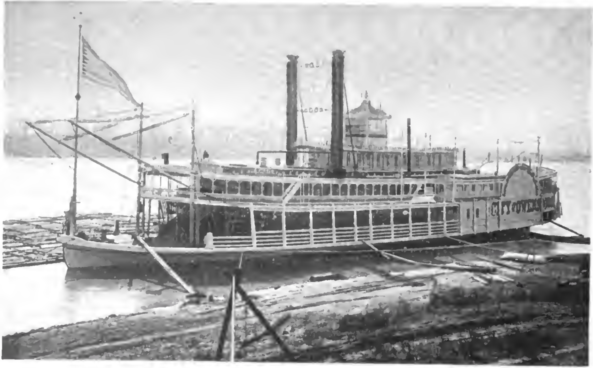
STEAMBOATING on the Mississippi and other western and southern rivers in the United States is in a state of arrested development. There was a time when the river-transportation interest boasted a certain splendor, but this for the most part has passed away. The railroads have made this deterioration inevitable, since in this more energetic era quick transit is the object in view of every traveler. Only a small percentage of passengers now go in search of the picturesque, and these are satisfied if what they seek is found at the end of their journey. When there was no way to go from Louisville, or St. Louis, or Memphis, to New Orleans, except by water, and when no means existed for shipping western farm-products through Atlantic seaports, the importance of river transit was necessarily very great. Magnificent boats were built, in keeping with the monopoly and the magnitude of the traffic on the Mississippi. The proud owner of a steamboat then put frequently as much as $150,000 or $200,000 in it, whereas now he would hesitate to invest $75,000. Before the civil war, and for several years after, boats went down the river carrying often as many as 10,000 bales of cotton. Now 3500 bales are considered about the limit. The floating palace has given place to the trim, plain, business-like steamboat, and the glory of the river has in a measure departed. But in late years there has been some indication of an improved state of affairs, and under conditions more favorable it is not improbable that the river will again become the most popular channel of travel in the Mississippi valley. Some probability of this is fairly deducible from the figures supplied in the "Statistical Abstract of the United States" for 1892, prepared under the direction of the Secretary of the Treasury. In 1878, for instance, the number of boats built on the Mississippi river and its tributaries was 460, with a tonnage of 68,928. From that year there was a steady decline in steamboat-building until 1886, when the number fell to 76, with a tonnage of only 10,595. Since then there has been an upward movement, as the table on the following page will show :

Google

YEAR ENDING—	Vessels built.	Tonnage.
June 30, 1886	76	10,595
June 30, 1887	79	10,901
June 30, 1888	84	11,859
June 30, 1889	83	12,202
June 30, 1890	104	16,506
June 30, 1891	114	19,984
June 30, 1892	99	14,800

It will be seen that in the first six years under review the number of steamboats built on the Mississippi and its tributaries nearly doubled, and that the tonnage came still nearer an increase of 100 per cent. While the figures for the last year for which official statistics have been compiled shows a falling off, it is worthy of note that boat-building on the great lakes was depressed almost as perceptibly during the same years as was boat-building for the rivers. The tonnage built on the lakes and on the entire seaboard was smaller during 1892 than for the preceding year, after having increased steadily for a few years previously. From unofficial sources there is reason to believe that the present year will make a better showing, and that the river-men are justified in hoping that their trade may yet experience the same vigorous impulse that has been felt in the lake shipping trade.

The first steamer on our western rivers was the *Orleans*, built by Fulton and Livingston at Pittsburgh, in 1811. It was a boat of about 200 tons burden, and its first trip was made from Pittsburgh, down the Ohio and Mississippi rivers, in December, arriving at New Orleans on Christmas evening. It was a stern wheeler, rigged with masts for sailing. It had no guards or upper works, and but one chimney, with the pilot-house in front. The speed of the craft was about three miles an hour. The next boat was the *Comet*, a stern-wheeler with vibrating engines, which were subsequently utilized for a cotton-factory. The *Enterprise*, a boat of not over 50 tons burden, built at Brownsville, on the Monongahela, was the first boat to make a direct trip from New Orleans to Louisville, in 1815. It took twenty-five days to make the trip, or about one-third the time in which one may now travel around the globe. The *Washington*, the first two decker, was built at Wheeling, West Virginia. Its boilers were located on the deck instead of in the hold, as had previously been the custom. In 1817 this boat left Shippingport (now a part of Louisville) for New Orleans, and

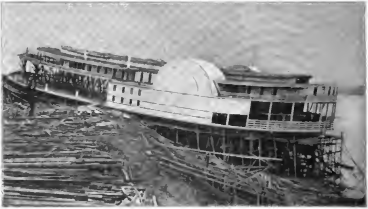


"CITY OF OWENSBORO," IN THE LOUISVILLE AND EVANSVILLE TRADE, OHIO RIVER.

[Built at Howard's Shipyard, Jeffersonville, Ind., in 1885. Length, 240 feet; beam, 38 feet; hold, 6 feet.]

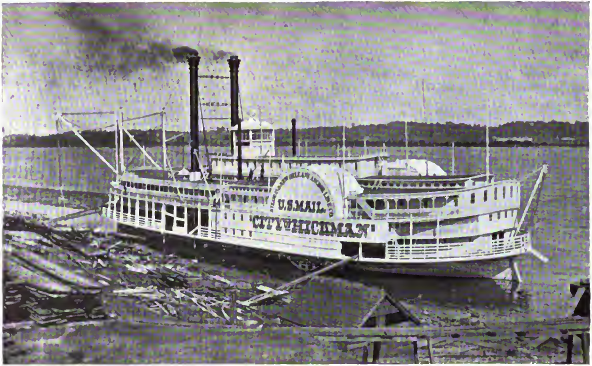
returned in forty-five days, thus demonstrating the success of river navigation.

Several boats were built between 1816 and 1818, which it is not necessary to recall, having possessed no peculiarities entitling them to specific mention. In 1818, however, was built the *General Pike*, the first steamboat on western waters for the exclusive convenience of passengers. She was constructed in Cincinnati, and her measurements were 100 feet keel, 25 feet beam, 40 feet length of cabin, and 24 feet breadth. At one end there were six and at the other eight state-rooms, divided in the middle by a passage, leaving in the center a hall, 40 by 18 feet, for the accommodation of passengers. The *Expedition* (120 tons) and the *Independence* (50 tons), built near Pittsburgh, were the first steamboats to stem the current of the Missouri river. The *Maid of Orleans* (100 tons) was a schooner-rigged steamboat, which sailed to New Orleans, and then steamed her way up the Mississippi to St. Louis, being the first boat that ever reached that city from an Atlantic port. In 1838 the *Diana* obtained from the Post-office Department a premium of $500 in gold for the distinction of being the first boat to make the trip from New Orleans to Louisville in less than six days. In 1846 the *Greek Slave*, built for the Tennessee-river trade, was the first boat to use the steam capstan. In 1851 the far-famed *Southern Belle* was built for the Vicksburg trade.



"JOHN W. CANNON" ON THE WAYS AT HOWARD'S, 1878.

This boat and the "J. M. White" were the two finest steamers ever built in the west. Length, 252½ feet; beam, 43 feet; hold, nine feet five inches. Cylinders, 34 inches; stroke, 9 feet; seven boilers.



"CITY OF HICKMAN," IN THE ST. LOUIS AND NEW ORLEANS TRADE, MISSISSIPPI RIVER.

[Built at Howard's Shipyard, Jeffersonville, Ind. Length, 300 feet. Cost $125,000.]

MISSISSIPPI STEAMER AT A COTTON-PLANTATION.

She was 241 feet keel, 31 feet beam, and 8 feet hold, and had the finest cabin ever seen up to that day. The *C. D. Jr.*, built in 1853 for New Orleans and the Bayou La Fourche, was the first boat that had a freight-hoisting engine. In 1854 the Howards, of Jeffersonville, Indiana, built for the Bayou Sara trade the *Capitol*, the fastest boat in the southwestern country. She was 235 feet in length, 35 feet beam, 8 feet hold, and had 30-inch cylinders, with 9 feet stroke and 6 boilers. The *J. A. Cotton* was built in 1860 for the coast trade. She had low pressure engines and was fleet as the wind.

During the war (1861–65) there was of course a hiatus in steamboating, but after it a number of magnificent boats were built. The largest boat before the war was the *Eclipse*, launched in 1852, which was 363 feet long, beam 36 feet, and the hold 9 feet. It had eight boilers, 32½ feet long and 42 inches in diameter. Its engines had a diameter of 36 inches and a stroke of 11 feet. The diameter of its water-wheels was 41 feet, and its buckets were 15 feet. After the war, the finest and the largest boats built were

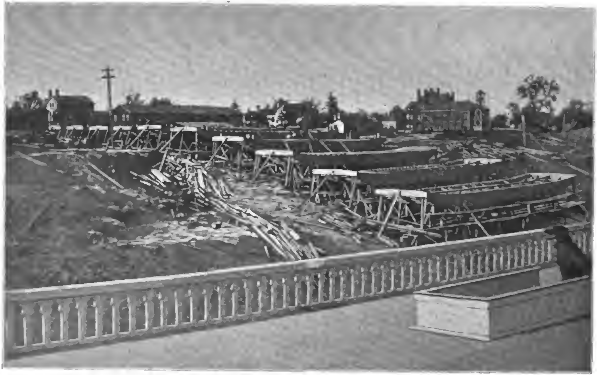
A COTTON-BOAT—THE "C. E. SATTERLEE."

Built by the Howards, at Jeffersonville, Ind., for the Texas and Pacific Railway. Length, 160 feet; beam, 30 feet; hold, 4½ feet.

the *R. E. Lee*, 200 feet length, 44 feet beam, and 10 feet hold; the *Frank Pargoud*, 250 feet length, 41 feet beam, 9⅓ feet hold; the *Natchez*, 301½ feet length, 42½ feet beam, and 9½ feet hold; the *R. E. Lee* again, 315 feet length, 48½ feet beam, and 10½ feet hold; the *John W. Cannon*, 250 feet length, 43 feet beam, and 9½ feet hold; and lastly, the *John M. White*, the model palace steamer of her time, built by the Howards of Jeffersonville, in 1878, for the New Orleans, Vicksburg, and Greenville trade. This boat was in some respects the acme of achievement in steamboat-building. The *Eclipse* had been a passenger boat, and it is said that she never made a cent for her owners. The *White* was not quite so long as the *Eclipse*, but she was a larger boat and was much more elaborately and powerfully equipped; and she carried both freight and passengers, and proved a handsome investment. Her length was 321 feet, beam 50 feet, hold 11½ feet, making a volume of 173,075 cubic feet, as against 117,612 cubic feet for the *Eclipse.* She had ten boilers, 34 feet in length and 42 inches in diameter; her engines had a diameter of 43 inches and a stroke of 11 feet, while her water-wheels were 44 feet in diameter and her buckets 19 feet. She could accommodate 250 passengers with state-rooms, and carry 10,000 bales of cotton. The cost of this handsome boat was $200,000.

As showing the difference between the river trade before the war and now, it is pertinent to say that formerly there was a daily line from Memphis to New Orleans, where now there is none; that the daily line to Cincinnati has dwindled to a semi-weekly; that the tri-weekly line to St. Louis has become a once-a-week affair; that the tri-weekly to Vicksburg and White river has been abandoned; that the boats which formerly made two trips a week up the St. Francis river now make one; and that the weekly trips to Obion river and up the Hatchie have been discontinued. Captain James Lee, the president of the Lee line of steamers, informed the writer that during his connection with steamboating freight rates had been reduced from $1 to 25 and 40 cents a barrel, that cotton

INTERIOR OF CABIN ON A STERN-WHEEL STEAMBOAT.



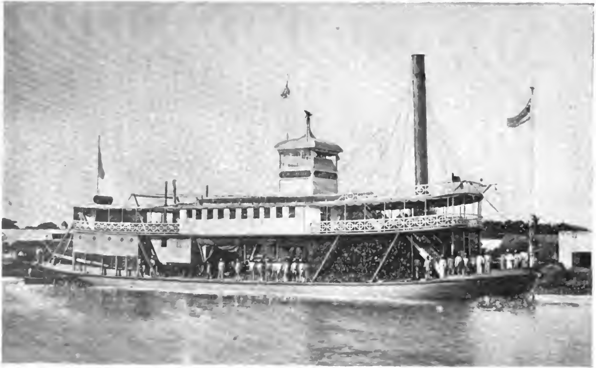
UNITED STATES GOVERNMENT FLATS FOR IMPROVING THE MISSOURI RIVER.

[This view, taken from the deck of a steamboat, shows ten of thirty-four flats, building at Howard's Shipyard; Jeffersonville, Ind.]

freights had dropped from $2 to 40 and 50 cents, and that there was now only about one-third of the river business that had been done formerly. The Lees were the first to inaugurate the short line system of three trips a week, a system which concentrates everything at a given point.

In the last ten years Memphis has become the second cotton market in the United States, and it may not be uninteresting to see just how far the railroads have affected the shipments of cotton to and from this point by river. These figures, for twenty-three years past, show that receipts and shipments have fluctuated considerably, but that the river has held its own in spite of the competition of the railroads and other influences. This is probably due to the fact that the cotton crop has increased about three-fold during this period, but the figures are important as proof that the river traffic cannot be done away with, and that it has a normal volume which may be expected to endure. For the season of 1870-71 the river receipts were 204,933 bales and the shipments 280,500. For the next three seasons the receipts averaged about 135,000 bales and the shipments about 140,000. For the season of 1874-75 the receipts as well as the shipments dropped below 100,000 bales. The following season the receipts ran up to 142,244 bales, and the shipments to 157,000. During the next ten years receipts fell off pretty steadily, until in 1884-85 they were only 90,000. During this time the shipments were in excess of the receipts, but from 1885 the shipments rapidly fell off, dropping from 123,825 in that year to 27,979 in 1891-92. But from 1885 to 1891 the receipts were as large as during any similar period in the cotton trade of the city, the average being about 140,000 bales. A variety of exceptional influences in the last two years has affected the trade, and so the river men handled in the season of '92-93 only some 76,000 bales all told. It looks very much as if the shipments by river from this port were virtually a thing of the past. No cotton is now sent south from Memphis by river; such as is shipped goes north. Of course boats will continue to bring cotton to Memphis and take it to other markets, and this line of traffic wlll hardly be affected by any change of conditions that can be conceived of.

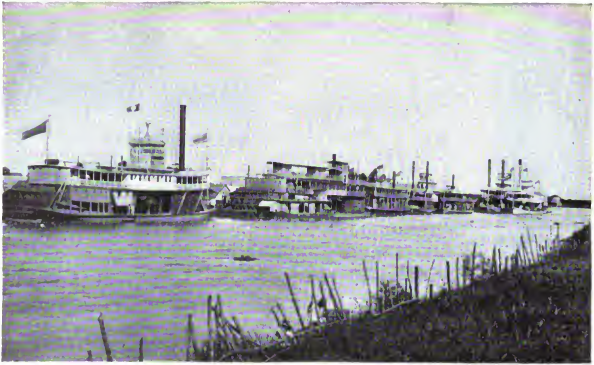
While the tendency in steamboat-building in later years has been in the direction of cheapness and compactness, there is one line of boats that may stand comparison with the gorgeous palaces of which the old river-men love to speak. This is the famous Anchor line, of St. Louis. It is said by those competent to judge



STEAMER "ENRIQUE," MAGDALENA RIVER, BUILT AT PITTSBURGH, PA.

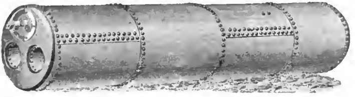
that the *City of Hickman* is as fine a boat as any of the old-time runners. It is not as elaborately decorated, perhaps, and not so richly furnished, but it embodies many improvements which were denied the boats of an earlier day. This steamer cost about $125,000, and for this sum there can be little doubt that a boat can be built to-day which would compare very favorably with the *White*, the *Lee*, or the *Pargoud*. The Anchor line maintains a number of boats of virtually the same type. The superb engines of these vessels could not be surpassed, and their hulls are as sound as it is possible to make them. They were built for the most part by the Howards, of Jeffersonville, on the Ohio. Their cabins are neat and spacious, but it is doubtful whether they are as elegantly fitted up as the famous boats of the past. These boats are about 300 feet in length, and they carry from 1200 to 2200 tons freight. They are named after different cities, and when one wishes to find some likeness to the splendid boats of river history, he can come very near it by examining the *City of New Orleans*, the *City of Hickman*, the *City of St. Louis*, or the *City of Cairo*.

In recent years a new arrival has made its appearance in the river business, which is the steel boat. It is the opinion of the most intelligent river-men that this kind of boat will eventually supersede all others. The pioneers in this kind of boat-building were James Rees & Sons, of Pittsburgh. This firm built some of the most beautiful boats ever used on the Mississippi, but about fifteen years ago they turned their attention to the construction of steel hulls for boats, and they have thus given an impulse to an entire revolution in the business. The steamer *Francisco Montoya*, the first steel hull steamboat ever constructed in the United States, was built at Pittsburgh in 1878 by James Rees, of the Duquesne engine works, for the South American trade. The hull was 140 feet long, 28 feet beam, four feet hold ; cylinder 15 inches diameter of the cylinder, with 5-foot stroke. A guarantee was given by the builder that the boat would run twelve miles an hour and carry 75 tons of freight in two feet of water. The boat was a great success, and is to-day running on the Magdalena river in Colombia. The first steel-hull steamboat built to run on the inland waters of the United States was the steamboat *Chattahoochee*, constructed by the same Pittsburgh firm in 1882. The hull was 155 feet long, 31 feet beam, 4½ feet hold ; cylinder 15 inches diameter, with a 5-foot stroke. This boat was built for the People's Steamboat Company, of Columbus, Georgia.



FLEET OF STEAMBOATS ON THE MAGDALENA RIVER, COLOMBIA, SOUTH AMERICA.

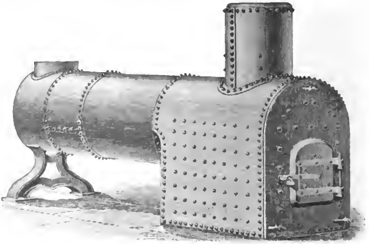
Built by James Rees & Sons, Pittsburgh, Pennsylvania, U. S. A.



STYLE OF BOILER COMMONLY USED ON STEAMBOATS.

Since January 1, 1880, the firm of James Rees & Sons have constructed twenty-three steel-hull steamboats for rivers in Nicaragua, and for the rivers Zulia, in Venezuela, and Magdalena, in Colombia. These are all typical light-draft river steamboats, having every facility for handling freight and passengers. The boats are all set up complete in the yards at Pittsburgh, then taken apart and shipped by rail to New York city, thence by vessel to South America. The cost of a steel hull is about three times that of a wooden hull of the same dimensions. The steel-hull boat will draw light, about one fifth less than the wooden hull of the same dimensions. The advantages of the steel hull in the way of permanence and safety need hardly be pointed out.

Howard's ship-yard at Jeffersonville, Indiana, is the largest in the United States under the exclusive control of one person. It



STYLE OF BOILER SOMETIMES USED ON RIVER STEAMERS, FOR COAL OR WOOD.

was established over forty years ago by Captain James Howard, and is now owned and controlled by Captain Ed. J. Howard, one of the best marine architects and builders in the country. It has turned out some 555 vessels of every description, some of them being the largest and finest on the Western waters. According to Captain Howard, the character of the work has changed very much in the last ten or fifteen years, the fine and fast palatial steamers of former times having been succeeded by small stern-wheel boats and barge lines. Captain Howard states that he is probably doing the same amount of work as formerly, but it is of the latter character ; he never has a call now for a *White*, a *Robert E. Lee*, or a *John W. Cannon*. He says in a letter to the writer, that, while steamboating is at a low ebb, " as long as the rivers of the west and south flow down stream, they will command a portion of the commerce of the great valley. Freight can now be carried cheaper by river than by rail, and if the items of expense—viz.: fuel and labor—could be reduced to a minimum, freight-rates could be reduced still lower, but it is only the local business along the banks or the through bulk grain trade to foreign ports that the river can legitimately hold."

The United States government is making every effort to improve the navigation, getting better depth of water during the summer season. The Howard yard is now building an experimental dredge-boat for the government to be operated on the Mississippi river between St. Louis and Cairo. If it proves a success in getting a better depth of water, it will have accomplished much for the river interests. What effect electricity may have in the river navigation of the future is, of course, problematical ; but it would not be surprising if, in this field as in almost every other, there should be a revolution.

There is now being built for the Lucas Navigation Company a steel boat which will ply between St. Louis and South America. This is in the nature of an experiment. If more intimate commercial relations are established between South America and the United States, it is possible that a very handsome trade will spring up between the Mississippi valley and our neighbors of the far South. It has been a dream of many people of this valley that some day would see ocean steamers in the ports of Vicksburg, Memphis, Cairo, and St. Louis. During the bridge celebration at Memphis last year the United States gunboat *Concord* not only went with ease as far north as Memphis, but it also reached Cairo, when it was recalled. There was formerly a navy-yard at Memphis, the value of which was not appreciated, and in later years there has been much talk of reëstablishing it. One of the chief arguments advanced for so doing is that in case of war an inland navy-yard is much better protected from foreign attack and reprisal than one on the coast. Whether this is ever done or not, there can be no good reason why the Mississippi valley should not maintain a direct connection with the sea, or why in the not distant future the river trade should not resume some of its old-time activity. Of course this activity will be exerted under new conditions.

The old time river life can hardly be duplicated to-day. It was absolutely unique. The big steamer was formerly a sort of floating improvised town. Some of the boats even had their newspapers, and gambling flourished without the slightest hindrance. Over forty years ago a newspaper was published on the steamer *James W. Woodruff*, edited by Captain C. S. Rogers, then clerk of the boat. The composing room was located beneath the ladies' cabin, and was in the charge of a single compositor. It contained personals about those who were on the boat, news picked up at the different landings, record of the distance run by the boat the day previous, and such news. These little papers were filled with the advertisements of those who sold the boat anything in the way of provisions, light, or fuel. They were sold in the morning to the passengers, who often paid as much as 25 cents for a copy. James Kerr, Jr., now of New Orleans, edited a paper on the Red-river steamer, the *Grand Era;* and Will L. Visscher, now of the State of Washington, won some journalistic laurels, as well as shekels, in this kind of work. There was also a paper called the *Richmond Headlight*, published on the steamer *Richmond*, plying between Cincinnati and New Orleans, edited by Robert R. Rea, now of Madison, Indiana. Features like this will probably have to be left out of the prospective revival of the river business.

Steamers like the *White*, the *Lee*, and the *Natchez*, would probably be run at a loss to-day on account of the railroad competition and the low land freights. Thus the steamboat of the future will offer a sort of compromise between beauty and speed. The reduction in freights was inevitable. Some old steamboat captains fondly refer to the time when they got $50 for carrying a bale of cotton, and there was a time when it cost $4 to carry 100 pounds of freight from Nashville to New Orleans. Such rates were absurd and inequitable, and of course they have been scaled down by the conditions of to-day's traffic. On the Ohio, it is reported that the river interests are looking up, and that the Cincinnati lines to Memphis and New Orleans on the one hand, and the lines to Louisville and Pittsburgh on the other, have pretty much all the freight they can handle. If the Ohio had deep water all the year round, the trade would be largely enhanced. From 1850 to 1861 Memphis shipped annually to New Orleans 300,000 bales of cotton by boat, and 100,000 more were picked up on the Arkansas and Mississippi coast. Now Memphis does not ship south at all. This, however, is not due entirely to the decadence of the river, but, as already pointed out, to the fact that Memphis has become a great cotton market, second only in importance and magnitude to New Orleans; and a vast amount of the staple that formerly found its way to that city now finds its way to Memphis.

Perhaps the greatest factor in keeping back the river traffic on the Mississippi has been the overflow. For four years past the lower lands have been under water once a year. These overflows have either destroyed a large amount of crops already planted, or have postponed the planting until it was too late to raise a good crop. Public and financial distrust is born of the overflow, and the shipping business is paralyzed. Indeed business in every branch suffers. Similar conditions prevail on the Missouri river. The daily line between St. Louis and St. Joseph and Omaha is now a once-a-week affair, and even that is poorly supported.

Two years of freedom from overflow, coupled with some efficient method of protecting the river-banks, would probably quadruple the river business on the Mississippi. The opening of the coal-fields in Kentucky and Alabama has been of advantage to the river, and has also been a good thing for the consumer. Pittsburgh coal was formerly sold at from 60 to 90 cents per bushel along the Mississippi; now it is from 32 to 35 cents, while Alabama and Kentucky coal can be had for 25 or 30 cents. This reduction is due to competition and to the river. That the revival of the river business is probable cannot be controverted by any keen observer; and under improved conditions a revolution is possible.

THE GROWTH OF COMMERCE ON THE LAKES.

By H. C. Pearson.

THE growth of our commerce on the lakes, even during the life of one man, is simply marvelous, utterly transcending the dreams of fiction. The details of its history read like fairy tales; but in a magazine article it is impossible to give more than an outline of the most remarkable development of marine traffic the world has ever known.

In the winter of 1833–34 Augustus Pickering, of Sackett's Harbor, New York, built what was then called a large vessel,—a schooner with dimensions thus stated by George L. Dickinson (now of Muskegon, Michigan), who was one of the carpenters who helped to build it: This vessel was as large as could be got through the wooden locks of the Welland canal, its length being 80 feet, breadth 20 feet, and depth of hold 8 feet. It was called the *Illinois*, and it sailed on May 12, 1834, with 104 passengers, for the village of Chicago. Mr. Dickinson and his young wife were among the passengers. The cargo consisted of the household goods and farming implements of the passengers, bound "for the far west," who availed themselves of this means of transit as the most convenient at the time,—railroads being unknown, and steam vessels hardly out of their swaddling clothes.

After calling at numerous places for resting the passengers and replenishing the stock of "sea-stores," the *Illinois* arrived off the mouth of the Chicago river (creek) about June 14, but it could neither land nor enter the "harbor," for there was no harbor, but instead a formidable bar across the mouth of the creek. There being no docks in what was called the harbor, no lights, no tugs, no anything but mud,—mud in the streets and out of the streets,—the passengers and light goods were put ashore by means of the ship's yawl, the heavier goods going by raft as the weather would admit. The only hotel being full, our passengers housed themselves as best they could, some finding shelter in a two-room log-cabin called a tavern, on the west side, though Captain Pickering succeeded, a short time after, in securing a small house of Mr. McKinzie, a government Indian agent.

After the cargo of the little schooner had been discharged, the people of the village told Captain Pickering that, as he had been gallant enough to name his vessel after their State, they wished to acknowledge the compliment in some fitting manner, and proposed to take his schooner over the bar (which carried but four feet of water), if such a thing were practicable; so that it might be said that a vessel had actually been in their harbor. After due consultation the idea was decided to be feasible. Accordingly anchors were carried out, a purchase rove to the windlass, and with much vigorous shouting, rolling of the schooner's booms, and heaving at the windlass, the thing was done, and the little schooner *Illinois* floated proudly in the port of Chicago,—the first vessel that ever graced that harbor.

But what a change in fifty-nine years! Then, as now, immense trains came into Chicago, but of different construction from those of the present day. Their motive power consisted of three to five yokes of oxen, and the cars were of the four-wheeled type instead of the modern "Pullman," covered with white duck, and called "prairie schooners." And now, from a hamlet of a dozen houses in 1832,—the place being organized as a village in 1833, and receiving the first vessel into her harbor in 1834,—her population is grown to more than 1,000,000.*

Besides gaining an enormous commerce, she has an immense iron-rolling and shipbuilding plant, has become the greatest primary grain market in the world, the greatest lumber market in the world, and the greatest meat-shipping center; and now she has at her doors the world's greatest industrial exposition.

Another marvel of growth, though on a smaller scale, is seen in the little town of Escanaba, an iron-ore center, in the northern part of Green Bay.

From the *Marine Record* (Cleveland) of February 12, 1893, are gathered the following facts: "In 1889, Bilboa, in Spain, with a population of 50,000, shipped 3,000,000 tons, while Escanaba shipped during the seven months shipping season of the same year 3,800,000 tons, the population being only 8000. So this little city, nestling under the pines of northern Michigan, sparkling with her electric light, cooling herself under her self-planted shade, besides her annual output of 200,000,000 feet of lumber, claims to be the largest iron port in the world."

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* The Chicago City Directory for 1893–94 contains about 500,000 names, which, if the usual ratio of total population to names in city directories obtains in Chicago, would indicate a remarkable growth since the last census, and that the population is now not far from 2,000,000.

The unprecedented and rapid growth of commerce on Lake Michigan, as seen in the marvelous growth of Chicago, Milwaukee, and Escanaba, is being repeated on Lake Superior. The germs of commerce on that lake are seen in the birch-bark canoes of the early Jesuit Fathers, in the latter part of the seventeenth century, winding their way along the coast on their exploring and missionary voyages, planting missionary stations at Marquette, Copper Harbor, Lapoint, and elsewhere. In 1680 Captain John Duluth visited the head of the lake, and soon after his brother built a trading-house on Minnesota Point.

The enterprise of these early pioneers was followed in 1803 by some hunters and trappers with a few small schooners engaged in the fur trade. In 1810 to 1812 two other schooners made their appearance on these waters. But Lake Superior, having no navigable inlet or outlet, though lying in the direct line of what was soon to be the great highway of a transcontinental commerce, could do nothing more than to employ a few of these small craft in the coasting trade. A change was near at hand. The prospect of the forthcoming North Pacific railroad, together with the favorable outlook for a canal and locks by the Sault Ste. Marie rapids, and the discovery of immense deposits of iron about the shores of the lake, stimulated enterprise. "In 1845, the propeller *Independence* was hauled overland at the 'Soo,' and successfully launched on the waters of Lake Superior. In the autumn of 1846 the *Julia Palmer* was also taken over and launched on that unsailed sea. And in the same season the little schooner *Uncle Tom* was run down the 'Soo' rapids because there were too many vessels on Lake Superior to pay." *

In 1855 the canal and lock at the "Soo" were opened to traffic, and the commerce of Superior was connected with that of the other lakes. This event had a marvelous effect in stimulating the growth of commerce on Lake Superior. The movement of ore, lumber, coal, grain, timber, flour, mining-machinery, milling-machinery, and every species of merchandise known to be required by people of a new country, began as if from spontaneous animation. And the fact was immediately developed that this canal and lock were not large enough,—that their capacity, though they had cost $3,000,000, would be speedily outgrown.

The necessity of increased capacity became so obvious that in

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* E. Ward in *Marine Record*, April 20, 1893.

1870 the present lock, with the corresponding enlargement of the canal, was ordered by the United States government at a cost of $2,250,000. The cells of this lock are 515'x80'x16'5" having about three times the capacity of the original lock; and yet this magnificent work—the finest single structure of the kind in the world—was soon seen to be inadequate to the demands to be made on it in the near future. Accordingly, still another lock, 800'x100'x22' 2", or double the capacity of the present one, was determined upon, and it is now in process of construction at an estimated cost of $5,000,000. The new lock is to be parallel with the present one, the pit occupying the site of the original lock. This improvement, of course, involves the widening and the deepening of the Sault Ste. Marie canal, throughout its entire length of 7000 feet.

The accuracy of observation by the officers of the canal concerning the growth of commerce to be provided for was amply vindicated by the amount of traffic for the year 1890, which was 9,041,213 tons, valued at $102,214,948;—lacking but a small amount of being double the commerce of 1885, and being 1,500,000 tons greater than for the preceding year.*

The Canadians, seeing the phenomenal growth of the Lake Superior commerce whlle yet but in its incipient stage, commenced the building of a canal and lock by the "Soo" rapids, of nearly the capacity of our new lock, and they have the work now well in hand.

Duluth, being at the head of navigation, occupies a position with regard to Lake Superior traffic analogous to that of Chicago on Lake Michigan; she must make provision for an immense transfer of tonnage. A glance at the newspapers will show what is being done there to meet the demands for the growth of commerce. "The Saginaw Lumber Company are doubling their dock room at their big mill at West Duluth, and will soon have 1½ miles of dock-front on two half-mile slips. This, with the Mitchel & McClure docks, will make three miles of dock-front, on four adjoining 2600-foot lots, affording dock room for 50,000,000 feet of lumber. The Duluth, Missabe and Northern railway will arrange for the building of another mammoth ore-dock shortly, close beside that now under way. It will be 2350 feet in length, and, with the exception of the present dock, will be the largest in the world. No similar area in the lumber world on the lake or elsewhere can produce such a collection of docks as these."*

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* See Report of General O. M. Poe, United States Army, in *Marine Record*, December 11, 1890.

The magnitude and depth of the new locks involved other and enormous outlays to make these improvements available. The Sault Ste. Marie canal must be again widened and deepened, as also must the Ste. Marie river, and the Detroit river, in many places ; and a new channel through Hay lake was determined upon for the double purpose of shortening the route about eleven miles and bringing the improvement entirely within the territory of the United States. In this work, excepting the lock, is entailed the largest expense of all, estimated at $2,500,000 to $3,000,000.

A consideration of the immense flow of the transcontinental commerce to come from the inexhaustible resources of the northwestern States as developed by the Northern Pacific railroad, together with the vast amount yet to come from Manitoba, the valley of the Sascatchewan, and the Red river of the north, and the measureless volume of ore to come from the newly discovered mines in northern Minnesota, has been the chief factor in determining on the enormous outlay for the improvements above mentioned.

Before one can fully comprehend the magnitude of some of this work, it must be seen. The mind can comprehend the relation of numbers, but can gain no idea of magnitude without the help of the eyes. Thus, the new lock-pit involved the excavation of about 1,000,000 cubic feet of earth and rock. Now this line of figures gives us no idea of the volume, for 1,000,000 in the abstract is utterly beyond our grasp. But going on the ground, we see the volume developed under its proper lineal units, and, when we can thus "take it in," get the idea of an elongated crater of a volcano rather than of artificial work.

The appliances for carrying on the work are on the same magnificent scale. In the pit above mentioned we will see a number of traveling or locomotive cranes, working on a truly "broad gage" of sixteen feet. These cranes take up a stone anywhere in the pit, and lay it down at any point within forty feet of the center of the tracks, the stones ranging from one ton to four or five tons each, or possibly more. The student of engineering will see numerous appliances for carrying on the work, which necessity, the prolific mother of invention, has devised. Among these will be found a machine for planing stone, precisely as we see a piece of iron planed in a machine-shop. Another notable machine is one for stopping the leaks that may occur under a coffer-dam, as in a fault of the rock, or between the timbers or cribs, and the bottom of the cut. This is a most important appliance. It consists of a well-boring auger, for sinking a well-tube, say four inches in diameter, through earth or rock to the leak. Then this tube is filled with cylinders of clay, which are driven down with a follower under the hammer of a pile-driver, ejecting the clay from the foot of the tube with tremendous force, even to the bursting of the embankment, or lifting the dam.

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* *Marine Record*, April 6, 1893.

The ice-boring machine is another device produced under the stimulus of Dame Necessity. With this machine two men can do the work of twelve to fourteen ice-choppers,—thus enabling Mr. Ripley, with a gang of men, to make over 60,000 soundings from the surface of ice for the purpose of determining the amount of excavation requisite for the new channel. Another machine is used on the same work for making the excavation in rock. This machine, being located precisely in line where wanted, by means of two transit instruments or otherwise, is firmly anchored by means of spud-anchors. It then drills holes to the depth of twenty-one feet,—three at a time, five feet apart each way,—drops ten pounds of dynamite in each hole, and fires the same, without moving, the bottom of this "drill scow" being made strong enough to stand the concussion of the shock twenty feet below. In this manner the channel is broken up 1300 feet wide, and the dredges follow, cleaning out to twenty-one feet deep in rock cutting and twenty feet in earth-work.

Then follows the "floating gage" for proving the depth of the work. I cannot do better than give the words of Professor J. B. Davis, of Ann Arbor, concerning this appliance. Referring to Mr. Ripley, in charge of the work, he says: "He has a float 120 feet in length, with a hole in the middle of it 100 feet long. Over the hole is a system of windlasses. From these, chains are suspended, connecting to iron bars. By means of instruments planted on the shore, he will locate the float at any desired point in the channel. Then, by means of a tug-boat or otherwise, he will move the scow (float) across the channel. The irons, being suspended from the chains, sunk to a depth of twenty-one feet, will sweep the bottom of the channel completely, over 100 feet of its length. There are men standing with their hands on every chain, and the instant the bars touch bottom it is known. The scow is stopped, the sounding rod is set on that spot, the men on shore locate it by means of their transits, and they find that stone if it isn't a couple of inches in size."

A little vessel of sixty tons, called the *Griffin*, was the first to spread sail on any of the western lakes. This vessel was built at the mouth of a small creek some six miles above Niagara Falls by La Salle, in 1679, and armed with seven small cannon, two of which were of brass. It was with much difficulty that it was towed up the Niagara river against the current. But finally, on August 7, a fair wind, supplemented with the efforts of a dozen men on a towline, brought the vessel into Lake Erie. She went to Green Bay, Lake Michigan, on a trading tour, and from this place she was sent back with a cargo of furs, a pilot, and five men, by La Salle, on September 10, but was never heard from after.

The *Walk-in-the-Water*, the first steamer to vex the waters of Lake Erie, was launched at Black Rock on May 28, 1818. As with the *Griffin*, much difficulty was met in getting her up against the swift current of the river. The strength of the engine was supplemented finally with oxen. She made her first trip to Detroit in the August following. Thus the *Griffin* and the *Walk-in-the-Water* were the pioneers of an immense commerce.

In June of 1795 La Rochefoucauld Laincourt visited this place, —called Buffalo by some, New Amsterdam by others. He speaks of an inn where he was obliged to sleep on the floor in his clothes, and in which there was neither rum, candles, nor milk.* Now the city of Buffalo claims a population of 300,000, and, after Chicago, she is the first commercial city of the lakes. The greatness of her commerce can best be seen by looking at some of her facilities for handling various materials and products. The new coal pockets of the Delaware, Lackawanna and Western railroad, of about one mile in length with a capacity of 100,000 tons storage, are but one of her many plants for handling coal. But it is in the handling of grain cargoes that her superiority over every other city in the world is seen. Prior to 1843, all transfers of cargoes were made by hand power, or horse power, the cargo being lifted in bags or tubs. But now Buffalo has thirty-two elevators, with a capacity of 13,000,000 bushels; ten transfers, and six floaters, or forty-eight in all, with a total capacity of 13,080,000 bushels storage, and a transfer capacity of 4,000,000 bushels per day.

The facilities for handling cargoes of coal and ores at Cleveland, and indeed in all lake-ports where these materials are moved, are on the same magnificent scale. This facility for the handling of cargoes on the lakes is the marvel of most people from abroad. It is no uncommon thing for a vessel carrying 3000 tons of ore to be loaded in from four to five hours, and with grain the despatch is even greater. But the greatest marvel to be seen on the great lakes is the wonderful stream of commerce traversing the river between Lake Huron and Lake Erie. Frequent countings by the marine reporters on the river at Port Huron indicate in round numbers 80,000 passages during the navigation season,—usually about 240 days. General O. M. Poe, in charge of the work at the "Soo" canal, reported the number of vessels of all kinds passing the locks in 1890 to be 10,557, with a total measurement of 8,454,435 tons, giving a fraction over 800 tons measurement for each vessel of every kind,—including yachts, tugs, and lighters,—and a fraction over 856 tons of freight carried for each individual passage, the total freight carried being 9,041,213 tons. At this rate we should see passing a single point thirteen or fourteen vessels per hour, during the whole season, each with an average cargo of 856 tons. At no other place in the world can such a stream of commerce be seen. Yet it is so little known abroad that in the Lloyd's (London) comprehensive tables of foreign and colonial shipbuilding for 1892 the work on the great lakes is completely ignored.

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* "Buffalo Annual," by John Lauchlin, for 1893.

THE NEED OF UNIFORM BUILDING LAWS.

By William J. Fryer.

THERE is a growing demand for greater uniformity, as between different States and cities, in laws bearing upon social and business or professional relations. Uniformity in divorce laws, for instance, has been strongly urged. Uniformity in laws regulating the transfers and registration of real estate has also been demanded, in order that a citizen of one State may be able to buy and sell in any other State as readily as in his own. Of all the subjects of legislation there is none in connection with which uniformity is more to be desired than that of regulating the construction of buildings. Yet uniformity in laws bearing upon affairs over which individual States have exclusive control—as is the case in America—can only be hoped for through the efforts of individuals or associations acting within the territorial lines of a State. The desired object is more readily obtainable, however, after some one State, by force of example, has cleared the way for other States to follow.

The progress made recently in the enactment of building laws, particularly in the Western States, has been due largely to the fire engineers. The chiefs of municipal fire departments have a powerful national association, and the members, when attending their annual conventions, hear much about methods of preventing as well as extinguishing fires, of fire-escapes for buildings, of slow-burning construction, of defective construction, of limitations to heights and areas of buildings, and of desirable regulations that exist in one city and not in others. They go home determined upon getting building ordinances for their respective cities, embracing the latest and most improved ideas. As the fire chief is an important and influential man in his own city, he can usually succeed when he tries to get any new regulation adopted.

A few years ago the firemen's association published a pamphlet containing suggestions for a model building ordinance. A joint committee from the American Institute of Architects, the National Association of Builders, the National Board of Fire Underwriters, and the National Association of Fire Engineers was appointed to prepare a model building law, but it has done practically nothing.

The fire underwriters are providing a universal schedule for rating risks from fire in buildings by laying down conditions which will constitute a standard building, supposed to include all approved methods of construction and arrangement, the intended effect being to induce owners, from self-interest in obtaining low rates of insurance, to build safer than they otherwise would in cities where there are no building laws.

One of the recognized methods of public protection of life and property is by building laws. A man has no natural rights in land and buildings. It is statutory law that secures the weak and strong alike in their peaceful holdings of property, which in the eyes of the law is theirs. Order and safety are maintained through forms of government established by the people themselves. It is their privilege to aid in securing the passage of wise laws and to obtain the repeal of bad ones, but it is also their duty to faithfully obey every law on the statute-books. It is to the credit of architects generally that they honestly comply with building laws, and their mistakes of non-compliance are unintentional, as a rule.

A perfect building law has not yet been drafted, and it is safe to say that it never will be. The building laws of London, Liverpool, Paris, Berlin, and other great foreign cities are poor models for American cities to follow, and upon investigation will be found to compare unfavorably with American laws, insufficient and faulty though the latter may generally be both from a legal standpoint and that of the builder. Building laws, like all other kinds of laws, will advance with the increase in intelligence and the general progress of the times. As new methods of construction come in vogue the law must take cognizance of them, and, as in the case of the modern skeleton construction, meet new conditions by providing reasonable safeguards. When a building is to be erected which is to tower above the limit of a fire department to successfully cope with fire, the whole community has a direct interest in demanding that it be so built as not to burn, or to topple over in a gale of wind. The humblest building, too, is rightly a subject for public solicitude. In a frame shanty the overturning of a lamp by the kick of a vicious cow started a conflagration that inflicted a loss of more than a hundred millions of dollars upon the citizens of Chicago, and, through the distributing medium of insurance, upon the whole of the United States.

For many years the laws of two States—New York and Massachusetts—have been principally taken as guides by law-makers in other States, and of the two, in more recent years, the laws of New York have been most in favor. When a legislator in a southern or western State desires to draft a law, he turns to the volumes containing the session laws of the State of New York, with almost a certainty of finding in them what he wants. Doubtless if the State of New York would enact a code of uniform building laws for her own cities, the other States would soon after adopt the same or similar laws. The need of suitable building laws for cities of moderate size has been long acknowledged, and is becoming greater every year, as such cities increase in population. Other States are as badly off as New York. Under legislative act Governor Flower of New York in 1892 appointed a Commission to draft and report uniform building laws in three classes applicable to the various cities of the State, excepting the cities of New York and Brooklyn. The task was a difficult and arduous one, requiring months of active and thoughtful attention. The charter of each city in the State had to be examined, together with the ordinances enacted thereunder relating to buildings. A copy of the building laws of every city in the United States known to have such a law was obtained and carefully studied, for, while the main idea of the Commission was to grade down the New York city laws, it was proposed to adopt good features found in the laws of other centers of population.

The New York city law formed the natural basis of this work, since it is the result of nearly fifteen years' continuous labor by competent and experienced men, and its comprehensiveness is, therefore, not to be wondered at. The betterment of that law was first taken in hand by individuals and commercial organizations, because their business interests compelled them to take some action, and circumstances so shaped themselves as to necessitate continuous and unremitting work. Architects, builders, fire underwriters, fire engineers, and lawyers have taken part in its several revisions. It is the united work of not less than fifty men, and from first to last perhaps the number has been closer to a hundred, numbering some of the ablest men in the various trades and professions represented.

Taking the New York city building law as a basis, the Commission scaled down its requirements, and in due time submitted to the State legislature three grades of proposed building laws for other cities. Chiefly for political reasons these laws failed to be enacted, though Governor Flower was known to be in hearty sympathy with the movement. At the next session of the legislature, however, they will again come up for consideration. In the opinion of the writer their acceptance and passage will be of the greatest benefit to the safety of human life throughout New York State, and, by their influence, throughout the whole country. Including the New York city laws, there have been proposed four uniform grades of building laws, applicable to cities from the largest size down to a population of 10,000.

About forty cities in the United States already have building laws, some of them of local adoption by the common council, and some of them enacted by the State legislature, when that power is not vested in the cities by their charters. A few of the older cities have had building laws for the past twenty-five years or longer, but even these cities have, for the most part, secured new laws or had their old ones amended to such an extent as to make them practically new. The following list gives the names of the principal cities having building laws and the dates at which the regulations now in force were adopted:

1893—Chicago, Ill.; Hartford, Conn.; Philadelphia, Pa.

1892—Boston, Mass.; Buffalo, N. Y.; New Orleans, La.; New York city; Providence, R. I.

1891—Albany, N. Y.; Baltimore, Md.; Indianapolis, Ind.; Minneapolis, Minn.; Syracuse, N. Y.; Washington, D. C.

1890—Butte, Mont.; Cleveland, O.; Detroit, Mich.; Kansas City, Mo.; Louisville, Ky.; Memphis, Tenn.; Milwaukee, Wis.; Sioux Falls, S. D.

1889—Denver, Col.; Seattle, Wash.; Tacoma, Wash.; Worcester, Mass.; Yonkers, N. Y.

1888—Brooklyn, N. Y.; Lynn, Mass.; Pittsburgh, Pa.

1887—Cincinnati, O.; Nashville, Tenn.; St. Louis, Mo.

1886—Wilmington, Del.

1877—Newark, N. J.

San Francisco, Cal., has an old law, but a new one is in course of preparation, it is stated. Newark, N. J., is preparing a new law. A new law for Brooklyn was recently hurriedly prepared by a Commission appointed by Mayor Boody, but awaits action by the next legislature. Several cities, including Charleston, S. C., have building ordinances scarely worth mentioning as such. Many of the laws are feeble imitations of an old Boston law, but more of them are, to a considerable extent, copied after an old New York law. A certain sort of broad uniformity runs through the whole lot.

The clothing of ideas in suitable language is a difficult matter in drafting building laws. Architects, builders, insurance men, and firemen have not the lingo of lawyers at their tongues' ends, nor do lawyers always readily grasp the meaning and force of building terms. One sentence in a law must not conflict with another sentence; one paragraph must not repeat something already stated in another paragraph, although mere repetition is of no serious consequence; nor must one section permit that which is prohibited in another section; and omissions must be looked out for as well. Annoying discrepancies and provoking mistakes are pretty sure to rise, sooner or later, to the chagrin of the compiler of the law. In the building law of New York city there is a requirement that every building hereafter erected to be used as a hotel, exceeding a stated height, must be fireproof, and every building hereafter altered to be occupied as a hotel must have the first floor constructed fireproof. The point has been raised and held to be well taken that a building already occupied as a hotel can be raised and otherwise altered without having to put in a fireproof floor on the first story. Although the framers of the law intended that new hotel buildings should be built entirely fireproof, and buildings altered to be occupied as hotels should be partly fireproof, they made no reference to buildings already occupied as hotels. Notwithstanding the revision committee's intent as to buildings altered from other uses to be occupied as hotels, a court recently decided that, by reason of another section in the law, which declares that no building already erected shall be altered in such a manner that, were such building wholly built or constructed after the passage of the law, it would be in violation of any of its provisions, therefore a building could not be altered for hotel uses unless the building was made entirely fireproof. An appeal to a higher court may secure a different interpretation of the meaning of these sections.

Trade prejudices frequently crop out in a committee engaged in preparing a building law. In Brooklyn's proposed law the selection for the chief officer for the Department of Buildings was at first to be confined to a "practical mason or carpenter." After some little discussion and persuasive argument an architect was added, so that the wording became "a practical mason or carpenter or architect,"—the architect being last in the order of their honorable mention. "Practical" persons will probably think the addition of an architect to the eligible list no great advantage in securing efficiency for the public service. Mention of this Brooklyn episode is made here simply to record a fact and not to exalt architects in general or "practical architects" in particular.

The New York city building law contains a unique provision in the way of a board of examiners made up of representatives from several trade associations. This board has power to vary the law in cases where it is claimed by an owner that the law does not directly apply or that an equally good or more desirable form of construction can be employed than that required by the law, so that the spirit of the law may be observed, the public safety secured, and substantial justice done. In the proposed New York State laws the superintendent of buildings is given full power to vary or modify the provisions of the law where there are practical difficulties in the way of carrying out the strict letter of the law, but, when the superintendent refuses to issue a permit, an appeal may be made by an applicant to three disinterested and competent persons, one to be appointed by the superintendent, a second by the applicant, and the two so chosen to select the third, and the decision of the board to be final and conclusive. The applicant is required to deposit with the superintendent thirty dollars when the appeal is made, and this money is paid out to the members of the board of appeal, ten dollars to each. Boston's law provides for a continuous board of appeal. St. Louis is considering the advisability of adopting the New York system, which is not by any means to be recommended.

The building laws of several other cities provide for appeals from the decision of the superintendent, but most of the laws contain no appeal clause. The right to appeal is an important one, and should be inserted in every building law. Superintendents are apt to develop human weaknesses and become dictatorial and arbitrary, and to forget that they are the servants and not the masters of the people. It is greatly to the interest of all concerned to have a building law comprehensive and clear, leaving as little as possible to the discretion of the superintendent and containing means to secure justice to an applicant. Where discretionary powers are vested in a superintendent, that official can be compelled to exercise them in a reasonable manner, for citizens have inviolate rights, but an appeal to courts is expensive and time-consuming. The wiser plan is to frame the building law in such a manner as will avoid serious conflicts between those who erect buildings and those who administer law. It does not follow that what a builder proposes to do or actually does is wrong in itself, for the things a law may prohibit at one time it may permit at another time, and that which is unlawful in one city may be lawful in another city. A law must be both rigid and flexible, not so straight that it cannot be bent, not so elastic as to be loose.

In manuscript form an ordinary building law is a voluminous writing, and a good memory, a watchful eye, and a clear head are prerequisites for the person who undertakes to keep the record straight in the preparatory stages of the work. Sharp lawyers will eventually probe the law for defects, unearthing a surprising number of defects. Learned judges will be called upon to interpret its meaning, and altogether the law will have to run a gauntlet of legal attacks until it is materially altered and changed, and afterward a new line of legal fire will be opened upon it. In respect to contentions, all the way up to the question of its constitutionality, a building law does not differ from a law relating to excise or to any other subject. It is an old and a trite saying that laws are made to be broken, and lawyers will ever try to break down law itself. But there is an axiom in law that for every wrong there is a remedy, and, while building laws have been lamentably faulty thus far, the process of evolution will better them as time rolls by and greater learning and skill are applied to their production. The drafting of building laws is a new branch of legal science, difficult, calling for a combination of talents, but possible to be done with precision. Building laws have become part of the jurisprudence of this country, and their number will multiply with the growth and increase in the number of cities. The production of wise, equitable, and uniform building laws is an interesting and patriotic work that invites the attention of the American people.

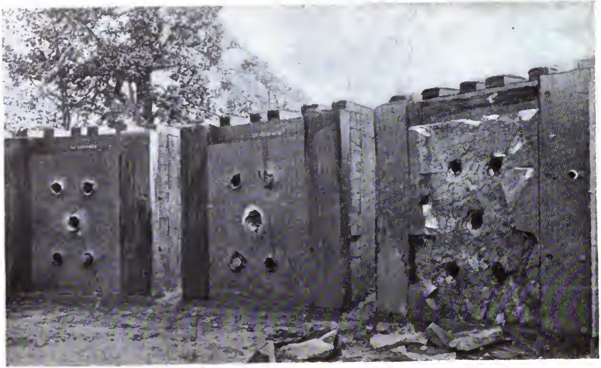
DEVELOPMENT OF THE NICKEL-STEEL ARMOR-PLATE.

By R. B. Dashiell, Ensign U. S. Navy.

AFTER the hurried completion during the late civil war of the monitors with their turrets of laminated iron plating, the United States government made no material progress of any kind in the development of armor until within the present decade. During this interval of nearly thirty years, however, the artillerists and plate-manufacturers of Europe had not been idle, and on foreign proving-grounds—in England, France, Germany, and Russia—the never ending contest between guns and armor was being continually waged with varying success. Laminated iron armor, after a tough resistance to the old-fashioned smooth-bore, yielded to the pointed chilled shot of the rifled gun. Solid iron plates long held the rifle shot at bay, but the increase in the size of the gun and its shot, and the consequent penetrating and smashing power of the latter, were greater than the resistance offered by the increase within practicable limits of the thickness of the plate.

Iron armor reached its full development in 1874 in the 24-inch plates of the English battle-ship *Inflexible*, but even this great vessel could carry barely enough of this armor to protect her vital parts alone. Before this, however, the insufficiency of iron armor was well-known, and experimental plates of two different types were already being tested on both sides of the English Channel. English armor-makers developed and brought to its greatest attainable perfection the compound plate. The French produced the steel plate. Both types appear fairly well developed in the "seventies." Each country clung with great tenacity to its own offspring, with but few advocates among the military authorities in the one for the type developed by the other, so that the two systems have become almost national,—all the later English fighting-ships carrying the compound, and French ships the all-steel plate, although several of the latter nationality have compound armor.

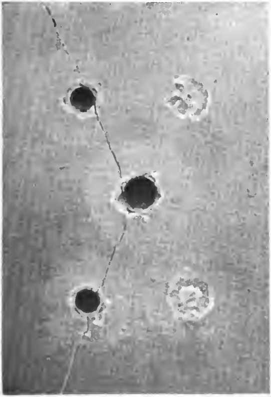
Following the English line of development:—The compound plate consists of a face of hard, but not necessarily "hardened," steel welded to a tough wrought-iron back. The steel face is



COMPETITIVE TRIALS OF FOREIGN ARMOR-PLATES AT ANNAPOLIS.

Steel Plate. Nickel-steel Plate. Compound Plate.

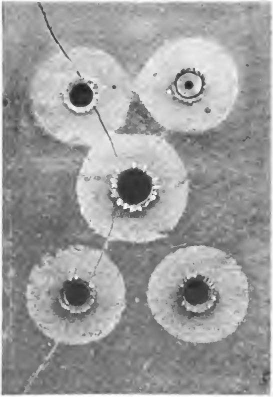
about one-third the thickness of the whole plate, and its object is to offer great resistance to penetration and breaking-effect on the shot, while the tough iron back prevents the plate from cracking to fragments and falling away piecemeal from the structure it should protect. The system has been quite successful.



10.5-INCH HIGH CARBON NICKEL-STEEL PLATE (HARVEYED)—BETHLEHEM IRON CO.

[After four 6-inch and one 8-inch shots.]

Across the channel, the homogeneous all-steel plate offered both its hardness and toughness to break and stop the projectile and yet remain in good shape upon its backing. But in the meantime a new factor entered the problem in the contemporaneous development of the armor-piercing shell, and both compound and steel plates were soon overmatched; the former were penetrated, the latter cracked and broken by shell which had attained such excellence as to be almost undeformed by impact on a steel plate. In the effort to meet this new element, the carbon of the steel face of the compound plate was carried as high as 1 per cent. to harden the surface and break the projectile, but the danger of the scaling off of the entire face prevented successful results. French armor-makers discovered remarkable projectile-breaking qualities, combined with great tenacity and resistance, in an alloy of nickel and steel, containing about 3 per cent. of nickel. Experiments showed its possibilities and good qualities even in the early plates, and in 1889-90 the armor-plate of nickel-steel had reached such a stage of development that its existence could not be overlooked by a government seeking the best type of armor for its battle-ships.

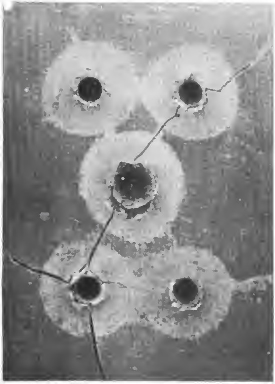


10.5-INCH HIGH CARBON NICKEL-STEEL PLATE—BETHLEHEM IRON CO.
[After four 6-inch and one 8-inch shots.]

In response to the invitation for a competitive trial of armor-plates extended by the Navy Department at Washington to foreign armor-makers—for there was as yet no plant in this country capable of producing a plate of the required thickness—three plates were submitted for test at Annapolis, Maryland, in the summer of 1890. These plates were all of the same dimensions, 6 feet by 8 feet, by 10.5 inches thickness. One was all-steel, one nickel-steel, and one compound. The first two were from the works of Henri Schneider, Le Creûsot, France; the third was from Cammel & Co., Sheffield, England. The three leading types of armor of most recent development were thus represented.

Each plate was submitted to four rounds with the 6-inch gun firing Holtzer steel shell with a striking velocity of 2075 feet per second, and then to one round from the 8-inch gun firing Firth steel shell with a striking velocity of 1850 ft. per second. These velocities were calculated to drive the shell just through a good homogeneous steel plate. The plates were bolted to oak backings 36 inches thick, which were in turn supported on non-yielding heavy structures of oak timber.*

The trials were conducted by a board of naval officers who unanimously reported in favor of the nickel-steel plate as being the best of the three tested. The nickel-steel and steel plates kept out all shots fired against them, but the latter was badly cracked at its center by the last round from the 8-inch gun. The compound plate was completely penetrated by all projectiles fired at it, and its steel face was destroyed. As has been often the case, the weld between the iron back and the steel face was the weak point in the plate. These trials were by far the most severe that any standard plate had yet been subjected to. They mark an epoch in the



10.5-INCH HIGH CARBON NICKEL-STEEL PLATE—CARNEGIE, PHIPPS & CO.
[After four 6 inch and one 8-inch shots.]

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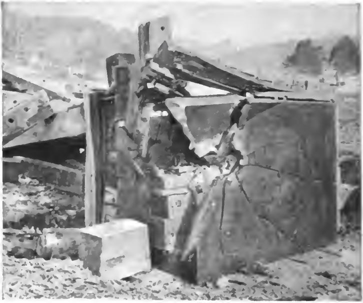
* It will be well to bear in mind that *all* plates are tested on similar structures, so that the conditions of trial are always the same and "standard."

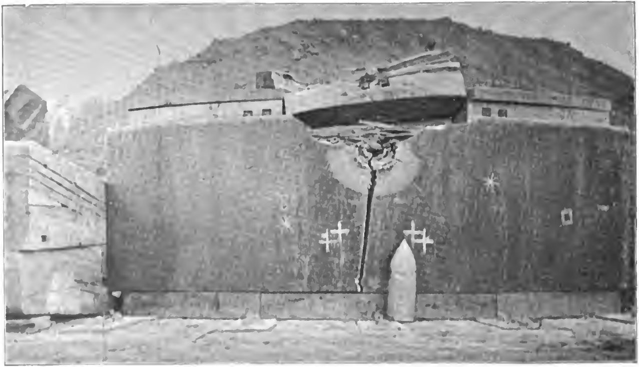


10-INCH STEEL PLATE—BETHLEHEM IRON CO.
[After one 10-inch shot.]

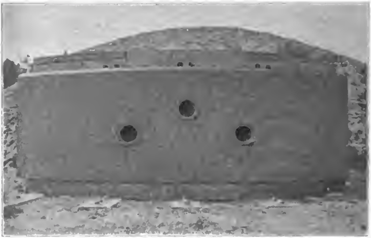
history of armor, and their conditions have become standards for comparison the world over.

As all plates for the new vessels were required by law to be of domestic manufacture, the Bethlehem Iron Company and Carnegie, Phipps & Co., foreseeing the necessities of the future, had for several years been engaged in completing the plants for turning out the armor as soon as the type could be finally decided upon. The first-named company use the hammer in working down the ingot to the plate, while the latter roll their armor. As both firms bid on the armor contracts, further experiment was necessary to settle between these two processes, for it must be borne in mind that the French steel and nickel plates described were hammered plates, and foreign steel-makers have always claimed that a good armor plate must be a hammered plate.

In preparation for this test, several small plates were submitted to firing trials with such gratifying results as to leave little doubt of the successful future of American armor. Plates were therefore manufactured by these firms, of exactly the same dimensions as



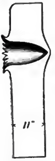
11-INCH STEEL ARMOR-PLATE WRECKED BY AN 8-INCH SHELL.



TEST-PLATE OF "MONTEREY'S" BARBETTE ARMOR.

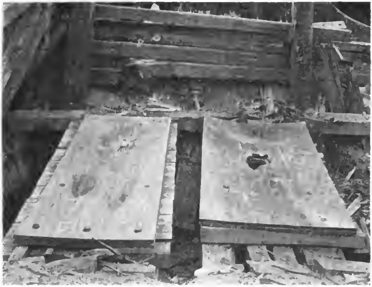
[11-inch Nickel-Steel Armor-Plate after three rounds from the 8-inch gun.]

those of the foreign plates tested in 1890. But as the compound plate became the rival of the solid iron plate in the "seventies," so does the Harveyed plate now appear on the scene, developed but slightly beyond the embryo state, but of such promise for the future as to warrant the entering of four Harveyed plates in the great competitive trial of the eight American plates in 1891. These plates were subjected to practically the same tests as had been given the foreign plates at Annapolis in the preceding year. The firing took place at Indian Head, Maryland, and this trial is the most important and extensive the world has yet seen,—both in the number of plates attacked as well as in the importance of the features in each plate to be decided upon in the competitive tests, viz.: nickel untreated plates *v.* nickel Harveyed plates, or all-steel Harveyed plates; low-carbon nickel *v.* high carbon nickel; rolled *v.* hammered plates; home made plates as compared with foreign plates tested at Annapolis, etc. The amount of information to be derived was enormous.



CROSS-SECTION THROUGH MIDDLE OF PLATE.

The best plate of the eight was the high-carbon nickel steel Harveyed from the Bethlehem Iron Company, and a close second was the high-carbon nickel-steel (untreated) plate from the same



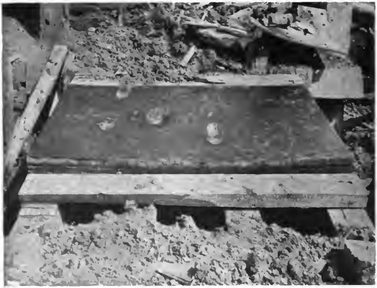
STEEL AND NICKEL-STEEL DECK-PLATES.

[After attack by 6-inch gun, steel deck perforated by pointed steel shells.]

firm. The first named was superior, and the second fully equal to the French nickel plate. Nickel steel armor of the first quality and of domestic manufacture was now an established fact. This material was at once adopted for the armor of the new ships, and the United States government was the first in the world to take this important step and adopt this metal which proved itself so superior to plain steel and compound armor.

As far as the processes of manufacture were concerned, the hammered plate was found better than the rolled, but the rolled plate proved itself no mean competitor, and all of them behaved so well that, when the cost of production was considered, it was a question as to whether the rolled plate were not the equal if not the superior of the hammered plate.

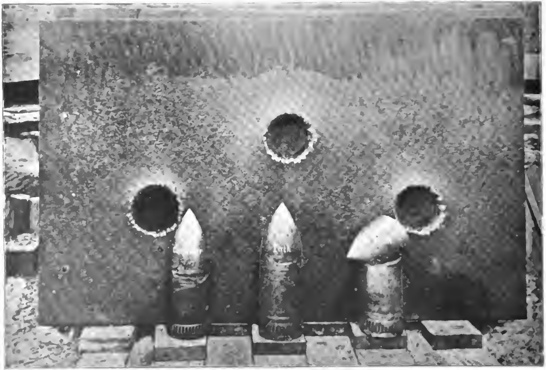
Three more trials on a smaller scale between steel and nickel must now be noted, for they were trials of material in the shape in which it was to be on board ship,—curved turrets and inclined decks. The curved turret plate was the *Monterey's* test-plate. The barbette or breastwork armor for this vessel had been ordered from the Bethlehem company before the armor trials of 1891, and



SECTION OF 6-INCH NICKEL-STEEL PROTECTIVE DECK OF THE CRUISER "NEW YORK."
[After attack by 6-inch steel shell.]

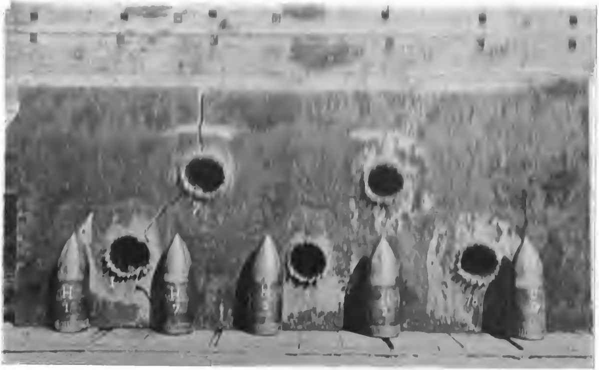
the Navy Department had specified the material to be steel. Before any batch of armor-plates is accepted by the government, one plate from the lot—known as the "test-plate" and usually selected from having some slight defect—is submitted to a ballistic test of three shots at the Proving-Ground. These shots are located on the plate in the apexes of a triangle whose sides are not less than 3½ calibers of the shot in length, and the requirements are that the plate shall not be penetrated nor its backing exposed before the third round. Narrow plates receive the shots in a horizontal line.

The test-plate of the lot of steel armor for the *Monterey* was eleven inches thick and was attacked with the 8-inch gun. It failed at the first shot, cracking from top to bottom and having a large piece knocked out of it. The lot was of course rejected, to be replaced in nickel steel. A few months later the Bethlehem company submitted a nickel-steel test plate of the same dimensions as the rejected steel plate. This plate received its three shots without a crack, all projectiles rebounding a hundred feet to the rear. The *Monterey* is thus the first man-of-war in any navy to carry armor of nickel-steel.



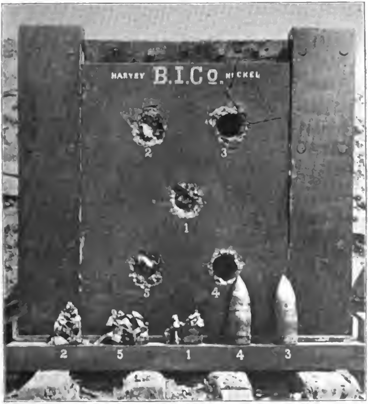
TEST-PLATE OF DIAGONAL ARMOR FOR THE BATTLE-SHIP "INDIANA."

[14-inch nickel-steel plate after three rounds from the 10-inch gun.]



TEST-PLATE FOR DIAGONAL ARMOR OF THE BATTLE-SHIP "MASSACHUSETTS."

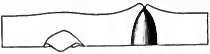
[14 inch Nickel-Steel Plate after five rounds from the [illegible]-inch gun.]

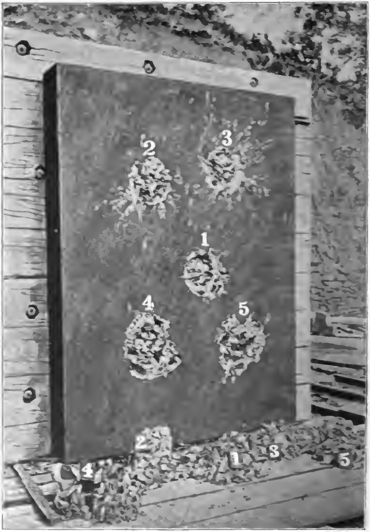


10.5-INCH HARVEY NICKEL—BETHLEHEM IRON CO.

[Cross-section given below shows effect of non-uniform face-hardening after five shots from the 8-inch gun.]

The question of the material for the inclined protective decks of cruisers is a very important one, for it is on the integrity of this deck that the safety of engines, boilers, and magazines depends in these unarmored vessels,—ships such as the *Baltimore* or *Philadelphia*, whose sides can be perforated by a musket-shot. To solve this question, a competitive trial was held at Indian Head between two sections of protective deck three inches thick, one of steel, the other of nickel-steel. These decks were attacked by the 6-inch gun, the line of fire being at an angle of 22

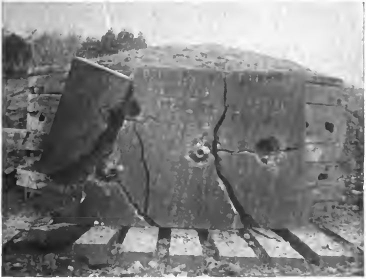




10.5-INCH HARVEYED NICKEL-STEEL PLATE—BETHLEHEM IRON CO.
[Five shots from the 8-inch gun.]

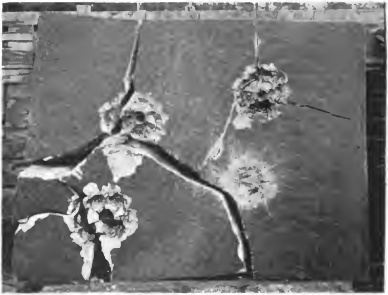
degrees with the surface of the plates. Four common cast-iron shell failed to make any impression upon either plate beyond slight dishing. A steel armor-piercing shell fired with full charge glanced harmlessly off the nickel-steel deck, while a similar shell with 11 per cent. less energy broke through the steel plate, burst beneath it, and completely wrecked the supporting structure. One such shell would have destroyed a cruiser had it struck near engines or boilers.

Another instructive comparative test of deck plates was something of a surprise in its results. Inclined plates of six inches thickness, representing the armored deck of the cruiser *New York*, were attacked with the 8-inch gun and steel shell. These plates were of steel and nickel-steel and were inclined 22° to the line of fire. The steel plate was badly cracked, but behaved very well, while the nickel-plate was knocked all to pieces as if it had been cast-iron. The cause for this lay in the high amount of carbon,—over forty points,—which had been worked in the steel to make it hard. A similar plate with about thirty points of carbon received all its shots, and deflected and broke them up, without suffering the least injury to itself beyond slight dishing. From the results of these and other similar experiments nickel-steel was adopted for the protective decks of all cruisers and battle ships under construction. All these deck plates are from the Pittsburgh firm and are of admirable qualities.



10-INCH CURVED HARVEY NICKEL PLATE.
[Attacked by 8-inch gun.]

The thickest rolled plate of nickel-steel armor yet turned out is the 13-inch plating for the sides of the *Monterey*. The representative plate passed a successful test with the 10-inch rifle and steel shell of 500 pounds weight. In a short time the Bethlehem firm presented a 14 inch hammered nickel-steel plate representing armor for the new battle-ship *Indiana*. This plate withstood three rounds from the 10-inch gun without a single crack. Its performance may be considered very remarkable.



14-INCH HARVEY NICKEL PLATE.

[After four rounds from the 10-inch gun and Holtzer steel shell with striking velocities of 1472, 1858, 1959, and 2059 feet per second; weight of each shell 500 pounds.]

These plates mark epochs in the development of nickel steel armor. Many other plates of this material had been tried with most gratifying results, but they were thinner than those already mentioned—varying from four to ten inches—and represented groups of armor for the different vessels under construction. Among these thinner plates, two deserve mention as specially excellent,—the 4-inch plate representing the side armor of the cruiser *New York* and the 9-inch armor for the sides of the monitor *Amphitrite*,—both from the rolls of Carnegie, Phipps & Co.

But satisfactory as nickel-steel untreated armor is as compared with its predecessors and rivals, it must be remembered that it is by no means the ideal plate either in theory or practice. It is not enough that an armor-plate stop an enemy's shot from getting into a ship ; more is demanded from the ideal plate. The behavior of a simple nickel-steel plate with regard to the projectile is nearly the same as that of the thick iron plate of twenty-five years ago, only on what might be called a more advanced and higher plane. As the iron plate soon reached its practicable maximum thickness and was superseded by the projectile-breaking compound plate, so the nickel plate for the same reasons will soon yield to some other type,—a plate which can do *more* than stop a projectile. The steel armor-piercing shell will give the nickel untreated plate the death-blow that the chilled iron shot has given the iron plate. The advance in plates has always been met by the advance in quality of projectile. The chilled-iron shot so long favored by the English has given place to American or French steel shell that can penetrate a thick plate of tough nickel-steel with such slight deformation as to permit being fired over again. Bearing this in mind, the necessity for a better plate than untreated nickel steel will be recognized. When a shot strikes a plate and remains entire, the whole energy of the blow goes into the plate and its supporting structure, and the racking effects on the latter are very serious. The shell for instance may rebound and not enter the ship, but if an entire turret crew are stunned and the gun-mountings knocked out of gear, such a shot might do more actual damage than if it had penetrated, and the plate has done but little towards protecting its structure. But if the energy of the blow can be thrown back into the shot itself and be expended in heat, melting or pulverizing the projectile, then the plate and structure are spared by the amount of energy so expended.

This principle was recognized long ago. The problem of a hard face and tough back was not solved satisfactorily by the compound plate ; but it does seem to be settled, for the present at least, by the Harveyed nickel-steel plate. The Harvey process, an American application to armor-plates of the well-known cementation process, consists in laying a good homogeneous plate (preferably of nickel-steel with about 3 per cent. nickel and about thirty points carbon) upon a bed of sand in which it is immersed flush with its face or top. Carbonaceous material is spread evenly over the bare surface, and the plate is heated in a special furnace and kept at a temperature sufficient to melt cast iron for a period of time found proper by experiment to effect the required carburization. It is then hauled out of the furnace, allowed to cool to a cherry red, cleaned off quickly, and quenched in cold water. The highly carburetted face is thus hardened to a depth of about one-third the thickness of the plate,—the back retaining its original qualities. Harveyed plates can be bent to the curves required, or, if warped, can be straightened under the press. This system has been proved to be thoroughly practicable, and it will be adopted for the new vessels as soon as plates can be had in required numbers.

Nickel-steel, when Harveyed, has always given better results than plain steel so treated. Some of the earlier plates showed a lack of uniformity in treatment, but the latest results have been magnificent. The 10-inch curved and the 10½-inch flat Harvey nickel plates have received 8-inch Holtzer shell which would have perforated the original nickel plates ; the projectiles were smashed on the surface, and the structures behind the plates were practically unharmed, even though the curved plate was broken from lack of a good backing and support to its ends.

A 14-inch Harvey nickel plate, when attacked with the 10-inch gun, broke the world's record for excellent armor. Four steel Holtzer shell, weighing 500 pounds each, were fired against this plate with striking velocities of 1472, 1859, 1957, and 2059 feet per second,—a total energy of 47,551 foot-tons. The last shot was directed at a fragment of the plate weighing only 4 4 tons and with a striking energy of 14,715 foot-tons, or 3344 foot-tons per ton of plate, an energy of attack nine times greater than the most severe ever given an armor plate of any other type at home or abroad. The resistance of the plate was without a parallel in the history of armor. The shell was smashed like all the others, the penetration was less than 11 inches, and the plate, though broken, fully protected the structure to which it was bolted.

The development of the nickel and the Harveyed nickel-steel plates has not been confined to the United States. The progress abroad has been but little behind that made at home, and all foreign results have been most fully corroborative of those obtained in this country. Nickel-steel armor, plain or Harveyed, is unquestionably the best armor known at present for naval purposes, and it should be a source of gratification to the country that this armor has been adopted for the United States Navy,—the first navy in the world to float the nickel-steel armor-plate.

ELECTRICITY AND ELECTRIC GENERATORS.

By Horace F. Parshall, M. Am. Inst. E. E.

OUR best thinkers never expect to know, absolutely, what electricity is, but rather how it is propagated, and how it is related to other phenomena. I think all will agree with me that this is all we can ever expect to know about anything, and that all knowledge is relative. All that science claims to do is to discover the relation between ascertaihed facts.

I shall first state, perhaps in a somewhat dogmatic fashion, the principal facts that are now thought to be firmly established concerning the nature of electricity:

Electricity cannot be created; it can only be moved or strained, and only possesses energy when it is in a state of motion or strain.

Electricity possesses something akin to energy, since we cannot change the current flowing in a circuit without an appreciable lapse of time.

All chemical compounds are made in accordance with the electrical properties of the atoms composing the molecules; in every molecule there is in combination an equal number of positively and negatively electrified atoms.

Electricity such as is generated on the surface of glass when it is rubbed with silk is electricity at rest in a state of strain, and is called *static electricity*.

Electricity generated by an ordinary dynamo or electric battery, known by heating, chemical, or magnetic effects, is electricity in motion, or *current electricity*.

Magnetism, known by the force which it exerts on magnetic bodies and by its capability to rotate a beam of light, is *electricity* in *rotation*.

Heat and light are electricity in a state of *vibration*.

Most of us feel that we know what light is, because of our happening to possess a special sense organ for its appreciation; but that it is subject to the same laws of reflection, and has the same laws as electro-magnetic induction, the only difference being in the wave lengths (visible light having a mean length of 1/50000", while electro-magnetic waves may be 18' long), we are not quite prepared by our senses to believe. It has, I suppose, occurred to

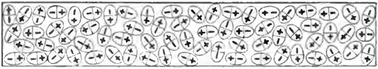


FIGURE 1.

[Arrangement of elementary magnets in an unpolarized magnetic material.]

every one that there may be natural phenomena of which we are ignorant on account of our having no special sense organ for their detection. It is well to bear this in mind when our skepticism of alleged discoveries becomes too marked ; it is also profitable to bear in mind the fallibility of all human testimony.

It is difficult to say to whom we should give most credit for the discovery of the facts that have led to the modern generalizations concerning electricity, but it is admitted by all scientists as fair to give a great deal of credit to our countryman, Benjamin Franklin, who, by his famous "kite experiment," in 1737, succeeded in drawing lightning from the clouds, thus establishing the identity of lightning with electricity. It seems amusing to note that, although his papers on this subject were at first laughed to scorn by the Royal Society of England, at a later time that society had to admit the truth of his experiments, and now the English text-books speak of Franklin's as one of the greatest British names connected with electricity. While his experiments related particularly to static electricity, or electricity in strain, his generalizations were practically those which we are now considering. When we consider the variety and scope of his work, the clearness with which he expressed his ideas and results, and that after the lapse of a century his work in every direction is still regarded as of the highest order, we feel justified in saying that no age or country has produced a more magnificent mind than that of Franklin.

The discoveries that have led to the principal commercial applications of electricity, however, have come to us through a different

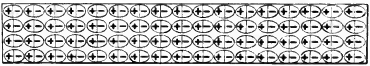


FIGURE 2.

[Arrangement of elementary magnets in a completely polarized magnetic material.]

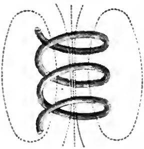


FIGURE 3.

[Amount and direction of magnetic flux due to a magnetizing coil entirely surrounded by air.]

channel. The discoveries of Cavendish, Galvani, Coulomb, and Volta are universally known, and it is due to the work of these men that Oersted, of Copenhagen, 1820, guided by theoretical anticipations, discovered that a current of a galvanic battery acted on a compass needle placed near the conducting wire; then Ampère discovered that currents of electricity attracted or repelled one another, according to their direction. Currents in the same direction attract; in the opposite direction repel. He further showed that the electric current is equivalent in its action to a magnet. Ampere's work seems remarkable when considered either from a mathematical or an experimental standpoint.

In 1825 Arago, of France, commenced his remarkable researches and established the influence of magnetism on all substances. Arago found that the oscillations of a magnetic needle made to swing back and forth over the surface of various materials, such as water, glass, or copper, diminishes more rapidly in the ex-

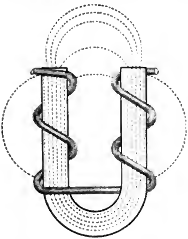


FIGURE 4.

[Amount and direction of magnetic flux due to a magnetizing coil partly surrounded by iron.]

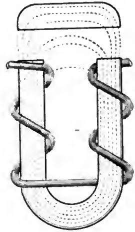


FIGURE 5.

[Amount and direction of magnetic flux due to completely surrounding the magnetizing coil with iron.]

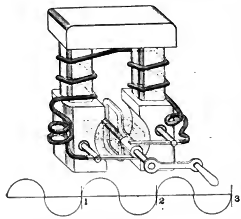


FIGURE 6.

[Elementary form of electric generator, the armature consisting of a single coil rotating between the poles of an electromagnet. The curve shows the electromotive force set up each instant by the motion of the coil.]

tent of its oscillations as it is approached to the surface, and finally discovered, by rotating rapidly a plate of metal near a compass needle free to rotate, that the needle would rotate with the plate. While this experiment embodies the principle of the modern dynamo, it was not understood by Arago, and was left for Faraday to make the generalizations that to-day seem to electricians so wonderful.

Before going further I am anxious to say a word concerning the very interesting character of Arago. Although he has been censured by our Anglican brothers for shrinking from the drudgery of science, the variety, scope, and clearness of his work place him almost beyond comprehension. As an astronomer his photometric measurements of the brightness of the moon and stars, the polar snows of Mars, and the belts of Jupiter and Saturn,—his applications of physics to the structure of the sun as revealed by the spots,—are indeed enough to give one man a lasting fame. It is, however, his investigations in optics that form the most marked feature and the greatest glory of his scientific career. He established

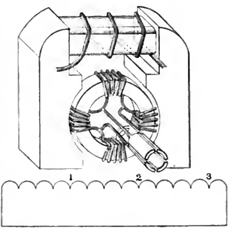


FIGURE 7.

[Elementary form of electric generator, the armature having two sets of coils. The curve shows the diminished fluctuations of electromotive force due to increasing the number of armature coils.]

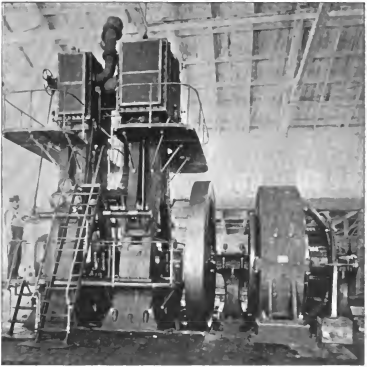


FIGURE 8—RAILWAY GENERATOR, WITH ENGINE.
[10 Pole, 750 Kilowatt, 1000 Horse-Power, 100 Revolution.]

the laws of the interference of polarized light, which involves the idea of transverse vibrations of ether, establishing the wave theory of light. Arago did not confine himself to science, but exerted a powerful political influence in his time as Minister of War and Marine. He also, in 1852, signified his intention to sacrifice his home and office as astronomer rather than take the oath of allegiance required by Louis Napoleon, since he had previously exerted his influence for the abolishment of all political oaths. The prince-president made an exception in Arago's favor, owing to the luster his scientific discoveries had thrown on France.

Almost simultaneously with Arago's work in magnetism, Michael Faraday commenced his researches in electric magnetism, and to-day when one reads the works of these two discoverers the feeling is induced that they seem to have breathed in the laws of

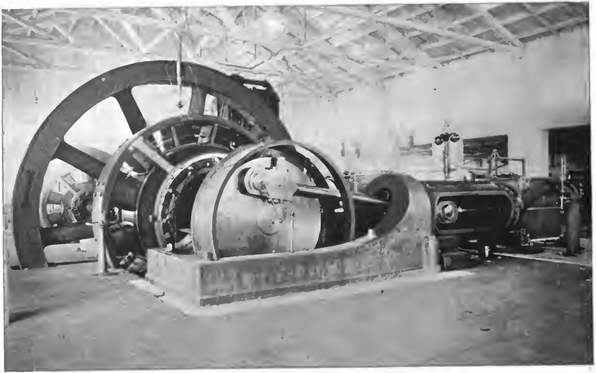


FIGURE 9 18 POLE, 1500 KW. (2000 H.-P.), 75 REVOLUTION RAILWAY GENERATOR, WITH ENGINE.

nature in their subtle form and to have breathed them out again in words so simple and clear that he who will may understand.

In reading Faraday's "Experimental Researches" one feels that he knew intuitively what each experiment would prove. In 1821 he obtained the first evidence that one electric current can induce another in a different circuit, and expressed his ideas so plainly that no one to this day has found a better formula. It is by the application of this one law that nearly every commercial use of electricity is made.

Faraday, in 1845, commenced a series of investigations on the effect of magnetism on light, and found that he could deflect a ray of polarized light with a magnet, thus establishing the relation between light and magnetism. This was at a later time interpreted by Maxwell to mean that the velocity of propagation of light and electro-magnetic induction are the same. Faraday's famous "ice-pail" experiment showed that, when positive electricity is carried in any region, there is simultaneously carried an equal amount of negative electricity; in other words, the amount of electricity in any place is constant.

This fact, together with the fact that electricity behaves like an incompressible, all-pervading, all-penetrating fluid, demonstrates that electricity is not a form of energy, and may be proved some day to be a form of matter. Electricity is material in nature, and does not possess energy unless under pressure or in motion.

Faraday discovered that electricity could be set in motion by reversing or moving a closed coil of wire in the vicinity of an electric magnet, and, since all commercial forms of electric generators are applications of this discovery, it seems warrantable that I should give this most careful explanation.

In the above statements I have assumed that the reader is familiar with the electro-magnet. Probably I have no right to make this assumption, for, if everything that happens in and around this piece of apparatus were definitely known, there would not be much left to learn about electricity.

I will try to start as near the beginning as possible by saying that a wire in which there is a current of electricity is always surrounded by magnetism and capable of exerting magnetic force, the amount of magnetism and the force it is capable of exerting being dependent upon the medium surrounding the wire.

I have stated, in other words, that it was one of Arago's discoveries that all known substances are affected by magnetism. We account for this by saying that all known substances consist of a great number of minute permanent magnets, similar to compass needles. These magnets, until acted upon by some external force, do not arrange themselves with their poles in any particular direction, and consequently do not exhibit any polarity, since the effect of one elementary magnet is counteracted by the effect of its neighbors. Such a state of affairs is shown in Figure 1 on a greatly magnified scale, each of the small figures representing an elementary magnet.

When, however, an electric current or magnet is brought to bear on a substance, these elementary magnets have a portion of their like poles turned into one direction so that their effects are no longer neutralized. The substance is then said to be polarized. Such an arrangement is shown in Figure 2.

Now, when a wire carrying an electric current is surrounded by air, the amount of magnetism generated near it is very limited, on account of the high resistance of air to polarization. If, however, we surround it with iron, under ordinary conditions, about two thousand times as much magnetism is generated as in air. Iron, in fact, is the only substance that can be very strongly polarized by an electric current. It is common to express this by saying that iron conducts magnetism under ordinary conditions two thousand times better than air. We find, however, that there is a limit to the amount of polarization of which iron is capable.

By referring to Figures 1 and 2, it will be apparent at once that the number of elementary magnets in any place is a limited, definite number, and that after we have turned all these in a certain direction there can be no further polarization. This is exactly what is believed to occur in a substance when it is saturated by magnetism, —*i. e.*, we have turned all of the elementary magnets in one direction. Further, we know by experiment that the amount of magnetism, in any material not saturated, increases with the amount of electricity, and the number of times the electricity passes around it; therefore, to get the greatest amount of magnetism through a piece of iron there must be a great number of turns of wire carrying a strong current around the iron. Under these conditions it is possible to get between two poles of the electro-magnet a pressure of 1000 pounds per square inch, and more.

Figure 3 shows a coil of wire carrying an electric current, with a few lines showing the amount of magnetism that would pass through it if no iron were present. Figure 4 shows such a coil of wire, in part surrounded by iron, the lines showing an increased amount of magnetism due to the presence of iron. Figure 5 shows such a coil with a complete circuit of iron through it and shows the increased amount of magnetism due to eliminating air entirely from the circuit of magnetism.

If I should revolve a closed coil of wire in front of an electromagnet, as shown in Figure 4, electricity would be started in motion around the coil.

The amount of electricity set in motion in the coil will depend, among other things, on the amount of magnetism going through the coil from the poles, the number of convolutions in the coil, and the number of revolutions in a given time.

It will be noticed that, when the coil is in one position, it includes all the magnetism, and, when it is at right angles to this position, it includes none. We are then varying the amount of magnetism in the coil. Electricians are in the habit of saying that by rotating a coil we cut the magnetism. This, however, is not literally correct. We simply let it into the coil and take it out again, and the relative motion between the coil and the magnetism (which is electricity in rotation) starts up an electric current in the circuit just the way a rope lying over a lot of loose pulleys commences to move when the pulleys are rotated. When we rotate this coil through the air, there are what we may call, for present purposes, " dead points " ; that is, in certain positions, though the coil is rotating, it has no relative motion with respect to the magnetism. In this place the coil is not generating electricity. The electricity generated by a coil rotating in this fashion varies during the rotation from zero to the maximum, and back again, and, when the direction of the coil is reversed with respect to the direction of the magnetism, the current is reversed and electricity flows in the other direction from zero to maximum, and then to zero. This, then, is what is known as an alternating current.

Suppose, as in Figure 5, we laid off in a horizontal line a number of equal distances corresponding to the circumference through which the periphery of this coil rotates with equal angular velocity. The amount of electricity generated at each instant could be shown by a curve. This curve shows what is commonly termed an alternating current. The electricity flows first in one direction and then another through the circuit. In ordinary practice these alternations occur about 200 times a second.

In some recent very interesting experiments, where the alternations were as high as 20,000,000 times a second, it was found possible to light an incandescent lamp through the body of the experimenter without serious consequences, since at this rate of alternations the resistance to the current of electricity was confined entirely to the surface of the conductors. Hence an extremely small current was required to incandescence the filament of the lamp. This interesting experiment demonstrates that the electric current, when passing through a conductor, requires an appreciable time to pass from the surface of the conductor to the center. In ordinary conductors the current will pass from the surface to the center in 1-5000 of a second.

Continuing with the small generator, suppose we had another coil at right angles to the first coil (see Figure 6); while one electric coil was generating no electricity, the other coil would be generating a maximum. The amount of electricity flowing would not vary to such a great extent as it did in the first case. [See Figure 7.]

Now the modern continuous current dynamo consists of a number of these coils connected so that the current is *always* forced through the circuit in the same direction. The number of coils is made so great that there is a constant amount of electricity put in motion. In practice we put a laminated iron cylinder inside the rotating coils (laminated so that useless currents will not be generated in it) to diminish the resistance to the magnetic flow.

If, instead of revolving the coil, as in the first case, we pass a current of electricity from some other source through it, it will rotate, and will exert almost the same force that is necessary to generate that current.

This, then, is an elementary example of an electro-motor, and I may say that there is no scientific difference between an electric motor and a generator; both are constructed in identically the same way. A generator is by reverse function a motor, and *vice versa.*

During the last year I have designed a line of very large generators for the General Electric Company. The largest of these generators to-day is several times larger than any that have been to this time constructed. These generators differ from those that have been in general use in that they are directly connected to the engine,—*i. e.*, the armature is keyed directly to the crank shaft of the engine; thus all belting is done away with, likewise considerable noise and liability to accident. Two of the largest sizes of these generators are in operation at the power station of the Intramural Railroad of the Columbian Exposition. The smaller one, shown with an Erie Vertical Engine in Figure 8, has a nominal output of 1000 horse-power at 100 revolutions, but has been worked up to nearly double this output without giving the slightest trouble. This smaller generator is capable of satisfactorily operating sixteen trains of four cars each, such as are now in operation on the intramural railroad.

The largest of these generators has a nominal output of 2000 horse-power at 75 revolutions, shown with an Allis Corliss engine in Figure 9. This generator weighs, approximately, 100 tons, and has in its construction steel castings that weigh 30,000 pounds. The armature (*i. e.*, the rotating member) is 10′ 6″ in diameter, and weighs, approximately, forty tons. The shaft is of forged steel and is 24″ in diameter. The weight of the engine is 300 tons, making the total weight of the combined plant—*i. e.*, engine and dynamo—400 tons. On account of the great weight and size of some of the parts, the dynamo was assembled and tested for the first time at the intramural power-station. Upon trial it was found to perfectly meet the conditions for which it was designed.

The most difficult problem involved in the construction of these generators is that of regulation. In practice the load is liable to vary from no load to 50 per cent. overload in a fraction of a minute, and unless there is a perfect balance between the armature and the field magnets there will be most vicious sparking of the commutator, and not infrequently in badly-designed machines the generator will flash,—*i. e.*, the sparking will extend all around the commutator and divert the current from the external circuit to the destruction of the generator and the danger of attendants. This phenomenon is most startling, and I am unable to adequately describe it. It is sufficient to say that such flashing will destroy everything in its course.

The other problems are: To calculate definitely the amount of magnetism to be generated at the magnet poles, the amount of iron necessary to carry this magnetism, the number of conductors that have to be placed on the armature (which is the scientific name for the revolving coil of wire described above), and the amount of heat generated by the resistance of its circuits to the passage of the electric currents generated. This last sentence may require further explanation.

It has been found by experiment that, when there is a passage of electricity through any conductor, there is always a certain amount of heat generated in that conductor. Just how this heat is generated I am unable to say from an experimental standpoint. I believe, however, that what happens is explainable on the supposition that each of the molecules composing the wire becomes agitated when placed under electric pressure and communicates its charge to the adjacent molecules, thus causing a current to pass. The motion of these molecules is accompanied with something akin to friction, and to this is due the heat. In commercial applications we use copper, since, with the exception of silver, this is the best conductor of electricity.

The amount of energy dissipated in the form of heat in a circuit with a given current of electricity has been definitely determined by experiment, and is always the same. In large generators the amount of heat generated in each portion of the machine must be most carefully determined, since, if any part of the machine becomes unduly hot, it is liable to break down; or, in other words, a "burn-out," as practical people are wont to call it, occurs.

The amount of damage that can be done by a misdirected electric current can hardly be estimated by one who has not witnessed it. It would be possible to volatilize a round iron rod 1½ inches in diameter by connecting it to the terminals of the second of the large generators previously mentioned. In fact, if a workman should accidentally connect the terminals of this machine by a crowbar, it is rather doubtful whether he would ever realize what had happened to the bar, since a good part of it would pass off in the form of metallic vapor, and it is somewhat doubtful whether he would know, for a while at least, what had happened to himself.

DISTANCE NOT A FACTOR IN THE COST OF RAILWAY TRAFFIC.

By James L. Cowles.

WHEN a train starts from Boston to San Francisco, it is impossible to tell the difference *in cost*, whether a passenger leaves that train at the first station out of Boston, or goes through to the Pacific coast.

" The proper basis of railroad tariffs is the cost of transportation," said Mr. Albert Fink to the Hepburn committee of the New York Legislature. Since distance costs practically nothing in the carriage of freight or passengers by rail, the charge should be the same for the longest distance as for the shortest. The ton-mile and passenger-mile basis of rates—wrong in principle and infinitely vicious in practice—is the root of the gravest evils in the railway business.

The best interests of the railways and of the people demand that on every railway system the rate for transportation between the two nearest stations at which trains stop shall be adopted as the common rate between any two stations on that system, regardless of distance and volume of traffic. This may be called the natural law of railway transportation. The railways are the main circulating system of the country, built especially for the development—the *harmonious development*—of the districts through which they run. An ideal condition will be attained when the consolidation of railway systems, now under way, has been completed, and the lowest rate charged between any two stations in each particular class of service has been adopted as the standard rate for such service between all the railway stations in our country.

The standard rate on passenger way-trains in the eastern part of the United States, under this rule, would be five cents per trip, and on express trains the rates would be practically in inverse proportion to the number of stops. If the stops on the express were one-fourth as many as on the way-train, the rates would be four times as much as on the way-train. Again, since Pullman cars weigh nearly twice as much as ordinary cars, and cost twice as much, while carrying hardly half as many passengers, the rates by Pullman cars would be *at least* four times as much as by ordinary cars.

President Roberts, of the Pennsylvania railroad, testified before the Interstate Commerce Committee of Congress last winter that passengers who traveled in Pullman cars did not pay half the cost of their transportation, and those who dined on the cars did not pay a quarter of the cost of their dinners. "It is the poor man," he said, "who sits in a common car, and sits two or three on a seat, who supports the railways of the country." Now, this practice should be changed. People who travel *en prince* must pay their share of the expense.

The freight rate per haul, on coal and products of its class, carried in open cars, and loaded and unloaded by shippers and consignees, might be 25 cents per ton. With a reasonable use of railway equipment it would be possible to discard both the tonnage rate and classification on open cars and make the standard rate per haul $7 per car of thirty tons. The rates on grain could be reduced to $1 per ton per haul, and on other commodities there could be corresponding reductions.

It must be patent to every one that the building of a railway implies the running of trains, and that these trains must run, whether they go well filled, or nearly empty. The weight of the lightest train, consisting of locomotive and tender, baggage-car, and one passenger-car, can hardly be less than 90 tons. If every seat should be filled, the weight of the train would be hardly increased five tons, the average weight of passengers not exceeding 150 pounds. What difference can it make in the *cost* of running that train whether it be full or empty?

At every station some passengers will be left, others will take their places. Perhaps one in a thousand will take the whole trip. There will always be room for him. And what is true of passengers is equally true of freight. The reason why railway transportation now costs so much per ton and per passenger is the mistaken policy of railway managers, which prohibits the proper use of their cars. Every passenger pays not only for the seat he occupies, but for a half-dozen seats kept empty by high rates; every freighter pays not only for the moving of his goods, but for the haulage of trains not used to a third part of their capacity. They are empty because high rates and discriminations in rates prevent their use. The load of the average passenger-train of the country is 41 passengers. The average freight train-load is only 175 tons. Not only are the loads of trains far below their capacity, but, as the editor of the *Railway Review* says:

The average *car movement* of the country is absurdly small, and it is so mainly because of the misuse of the car by the railways themselves. Mr. W. H. Wheatly estimates the waste of capital in this misused equipment to be $124,000,000, with an interest account of at least $5,000,000. The cost of maintenance of this *useless* equipment is about $10,000,000 per year, to say nothing of the cost of track-room to hold them, locomotives to move them, and the other minor, yet necessary, expenses which their existence involves.

If the 1,100,000 freight-cars in service in the United States in 1890 had made but two paying hauls a week, at $7 per car per haul, irrespective of distance and of classification, their earnings would have been over $800,000,000, whereas their actual earnings were $714,464,277. If the passenger-trains that year had averaged 100 passengers each, instead of 41, they would have earned, *at 25 cents a passenger per trip*, over $300,000,000, instead of only $260,786,453. It is to be remembered that 100 passengers fill hardly three-fourths the seating capacity of two passenger-cars, and that those cars are emptied, on an average, every twenty-five miles. According to the statement made by Mr. Depew, president of the New York Central, before the Interstate Commerce Committee of the House of Representatives last winter, it appears that, while freight rates have been reduced *but one half*, the cost of handling freight has been reduced *five fold*. "So that we can carry *1000 tons now as easily as we formerly could 200*." The rates, therefore, instead of being *one-half*, should be but *one-fifth* as much as they *were formerly*.

Is there not some opportunity for increasing the number of passengers and of tons of freight carried on our roads and *making a proportionate decrease of rates*, without increase of operating expenses? Would not the scheme here suggested produce exactly this result? The essential thing to keep in mind is that differences in the train-loads make no practical difference in the cost of moving the trains. Mr. Stroudley, locomotive superintendent of the London, Brighton and South Coast railway, says that in a locomotive of his design one pound of coal will convey a ton of train-load 13.5 miles, at an average speed of 43 38 miles per hour. At that rate a ton of coal costing $4 would carry a ton of freight round the world, on a well-constructed railway, in less than a month, and 250 pounds of coal would carry 10 passengers weighing 200 pounds each from New York to the Golden Gate in about three days. Mr. W. M. Acworth says that an English locomotive with a load of 50 tons will burn 20 pounds of coal per mile; when hauling 600 tons, it will burn perhaps 60 pounds, so that between no load and a long, heavily-laden train the variation of *locomotive-cost per mile* is hardly more than the cost of 40 pounds of coal, say 8 cents. Mr. A. M. Wellington, in his work, "The Economic Theory of Railway Location," says that "the addition of 30 tons dead weight (and live weight is no heavier than dead weight) to a train of, say, five cars, will not increase the expense for coal in this country over one cent a mile." Since all the passengers that can be squeezed into five cars will not weigh 30 tons, it therefore follows that the difference in the cost of fuel on a five car train carrying 340 passengers and such a train with no passengers is not more than one cent a mile. The addition of three cars to a five car train will require only 22 pounds more coal per mile, costing perhaps four cents; and the only other additional expense will be the wages of one or two extra hands, interest on the cost of three extra cars, and their repairs. If this five-car train be scheduled to run from Boston to San Francisco, the addition of three cars capable of carrying 200 more passengers will not cost over $200, or *$1 per passenger.*

As to increased wear of track from heavier trains, three-fourths of that expense is due to the locomotive, so that it makes practically no difference in this respect whether a locomotive runs alone or with a train of full-loaded cars. Professor Hadley says:

> On any line where a good canal can run, a railroad can handle a net train load of 600 tons, at a direct expense, for fuel, trainmen, and train repairs,—*that is for haulage,*—of not over 40 cents, and sometimes as low as 30 cents, or from *1/20 to 1/15 of a cent per ton* per mile. In other words, the cost of transporting a net train load of 600 tons across the continent would be only from $900 to $1200; or from $1.50 to $2 per ton on any line where a good canal could run.

But since single engines in the United States have hauled trains of 1200 and 1300 tons, I think it only fair to assume that the rate per ton on such trains would not be above Professor Hadley's figures, although it is necessary on the trans-continental trips to go over very high grades. For the average haul of the country (120 miles) the cost of haulage of a net train-load is not over $48, and may be as low as $36, or from 6 to 8 cents *per ton per haul;* for New England *the rate per ton for* the *average* haul of 70 miles will vary from 3½ to 4½ cents.

These facts prove that the cost of moving one ton or one passenger, on heavy through trains, even for the longest journey, is very small, and on short trips it is infinitesimal. Taking all the circumstances together, I believe that the cost per ton and per passenger is practically the same on the heavily-laden through train and on the comparatively light way-train. First, the through locomotive hauls on an average a larger number of full-loaded freight cars than does the way locomotive. Mr. Fink makes the average load of the through-freight car nearly three times that of the way-car. Through trains have been run from Chicago to New York with 40 and 45 full-loaded cars of 30 tons each.

Again, the through train runs much faster than the way-train. It wastes neither the time nor the fuel lost by the way-train in frequent stops. On the Manhattan elevated roads of New York it is estimated that three-quarters of the coal consumed and one-third of the time occupied are lost in stops. Our fast freight trains make 350 miles a day, and some of our fastest expresses run 1000 miles a day. The way freight-train hardly makes 90 miles, and the way passenger-train averages less than 100 miles a day. The way-train then must make three or four short trips in order to handle as much freight as is handled by the through train in one long trip. It is probable that our through locomotives handle more tons of freight per locomotive per year than do way locomotives of the same capacity. Instead of consuming time and fuel in stops, the through locomotive occupies itself in flying between its widely-separated terminals. The cost of loading and unloading through freight, which often runs in car-loads, is less than the cost of handling way-freight, which usually runs in small consignments. In Chicago it was found to cost 23 cents per ton for handling way freight in lots smaller than car-loads, and only 9 cents per ton for handling car-loads of through freights.

But the average passenger trip and the average haul of freight will always be short. If railway transportation were absolutely free, the world would not go flying, neither would any country be flooded with the products of any other. Under any circumstances the average trip of the traveler by rail in the United States would probably be no greater than it has been for the last eight years, —about 25 miles. And the average haul per ton of freight would not be over 125 miles, a fair day's haul.

The masses must always labor for their bread. They can seldom spare the time for more than an hour's journey from home. Their factories, shops, schools, and pleasure-resorts must always be near at hand. The bulk of the freight business must always consist in the exchange of products between neighbors. This, indeed, is the prime object of railways. "The through business," says Mr. Fink, "is but *a mere incident of a road.* The mainstay of a road, is or ought to be, local traffic." The "local traffic" of the Pennsylvania road, in 1881-85, was ten times greater than the "through traffic," and of the two the way-traffic continues to increase much the more rapidly.

I have now demonstrated that distance costs practically nothing in railway transportation. A man or a ton of freight is no more to a railway-train than a fly is to an elephant. And a train load of passengers is no more to a train than a swarm of flies is to an elephant. It is no more possible to measure the difference in the cost of hauling a passenger or a ton of freight over different lengths of a railroad system than it is to measure the difference in the efforts of the human heart, whether the blood is carried from one valve of the heart to the other or from the life-center to the finger tips. The railways are the main circulating system of the country; the tracks are the arteries and veins, and the train the life-bearing current. The harmonious and healthy development of the country, and of the railways as well, requires that the flow of this life-current shall be regulated by a law as uniform and stable as that regulating the flow of blood in the human body.

The post-office system, in which the rate adopted for the shortest distance between stops on any route, is the rate for all distances, and which secures to every individual the same rate for the same class of service, offers the very law we need. For fifty years this principle has determined the world's practice in the transportation of letters and newspapers. Now a two-cent stamp will send a letter from Eastport, Maine, to Seattle, in Washington. Is there any essential difference between the transportation of the mails and the transportation of other freight and of passengers? On some railways the mails *weigh* almost a tenth as much as the passengers carried, and the actual income of American railways from the carriage of the mails in 1890 was nearly one-tenth as much as from the passenger traffic.

But the test of this principle has not been confined to the transportation of mail-matter. It has been adopted almost universally on the supplementary circulating systems,—namely, on horse-car lines and electric tramways. We have a remarkable instance of its magical influence in the case of the elevated railways of New York. For two years I watched its working in Birmingham, Alabama, and saw what had been accomplished by its application, in the building up of the ironworks of that district. The rates on the raw materials of the iron manufacture were 25 cents a ton from any one station to any other on the Birmingham mineral road, within twenty miles of the center of the city. For a year past I have watched the influence of the five-cent rate per trip on the electric lines about Boston.

We have all heard what the application of the postal principle, in a restricted form, has accomplished on the Hungarian railways. In the first eight months of the experiment the general traffic increased 169 per cent. over that of the last corresponding eight months of the old system, while the traffic between neighboring stations increased still more rapidly; from 225,000 to 4,367,586, without any increase of operating expenses, while the receipts increased 18 per cent. Instances are not wanting of the use of this principle on the general railway system of this country. The rate from New York to Birmingham is the same by several different routes, though the route in one case may be half as long again as in another. The grouping of freight rates is very common. The rates are the same for the same class of products from different points in New England to the same commercial center in the west. Coal rates are the same from New Haven, Connecticut, to Mt. Carmel, nine miles distant, and to Westfield, sixty miles away.

There is however no *common law* observed in the determination of railroad tariffs. Through tariffs between terminals are based, as the *Railway Review* tersely puts it, on "guess work modified by a comparison," and the comparison always favors the big dealer and the big terminal. In local traffic, where the power of the railway manager is absolute, ton-miles and passenger-miles are measured out with the greatest care, notwithstanding it has been condemned by some of the highest authorities in the railway world. At a meeting of the American Railway Association (representing two-thirds of the mileage of the United States) held in New York, in October, 1891, the president, Mr. H. S. Haines (who is also vice president of the Plant railway system), declared the ton-mile unit to be fallacious, misleading, and without value to the railway traffic manager, and the unit of cost per passenger mile to be equally fallacious and valueless. "*The entrance of a single passenger in a train adds nothing to the cost of moving that train, and the cost of transporting a single passenger is therefore inappreciable.*" A passenger does not measure his desire to get to a place by the number of miles he must travel to reach it, and "whether he goes fifty or sixty miles [yes, whether he goes one mile or 3000] it costs the same to carry him if the train be scheduled for the longer distance and there be room for him." . . . . "The idea of rate for distance does not prevail in making freight rates." Then why do railway officials continue to make their reports on the mileage basis and to measure out miles so carefully in local rate-sheets? The answer is easily given. "It is not," says Mr. Wellington, "because there is any natural equity in it, neither is it because it is in accordance with the public interest. As a question of purely public policy, the effect of distance on revenue should not be considered at all." It is because the local traveler *thinks* that distance is the main factor in the cost of railway traffic, and because it seems to the railway manager to be profitable to foster this idea, although he knows it to be fallacious, and begs his friends not to do him the injustice to imagine that he is controlled by it in (*through*) business. As for profits, it enables the railway manager to exact from the local traffic rates 50 to 75 per cent. higher than are levied upon through traffic. To this extent the *false* mileage-system of rates burdens small cities and small dealers more than the larger cities and the larger dealers.

Mr. Wellington also says that this further evil follows: namely, where rates are actually determined by distance alone, any *reduction* of *distance* would be apt to entail a loss upon the company. "For example, it would undoubtedly entail a net loss on the New York Central railroad, *from their way business alone*, to shorten their lines by several miles, *even if it could be done without cost to them*, provided all their business, 'way' as well as 'through,' had to be transported over the new line." Taking the average train-load at 100 passengers, one-half will be local passengers subject to the full tariff of two cents a mile. The gross revenue from fifty local travelers will be $1 per mile, but the cost of running the train a mile is not over 60 cents. The net revenue, therefore, of 40 cents per train per mile now exacted from local travelers would be lost for every mile cut out of the line. In other words, under this false mileage-basis of rates the fifty local travelers on each train are compelled to pay not only a profit of 40 cents a mile above the cost of their own transportation, but also to pay the entire cost of the transportation of fifty through passengers. This business is so profitable, says Mr. Wellington, "that we seem driven to the conclusion that it is rather worse than money thrown away for the average road to spend money in shortening its line." The more miles between stations, the more miles to be taxed to the local traveler.

It only remains to add that, under this misleading and unfair system of rates, according to the testimony of President Depew before the Interstate Commerce Committee of the House of Representatives, last winter, the smaller places and the smaller dealers of the country, obliged to pay these high local rates, are being rapidly wiped out of existence, and the business of the country is concentrating itself in the large terminals and in the hands of the larger dealers who obtain low through rates *regardless of distance.* Mr. Depew attributes this evil tendency to the Interstate Commerce act, and he is reported to have said before a committee of the United States Senate:

> It is a matter of time only when the small dealer who is compelled to pay the regular tariff will go to the wall. If this law, the Interstate Commerce law, continues in force five years longer, there will not be an independent business man in any of the large cities of the United States.

But the present condition, I respectfully submit, is not due to the anti-pooling section of the Interstate Commerce act, or to any other act of Congress, but rather to those whom Mr. Bryce, in "The American Commonwealth," has styled our "railway kings," —who, to the injury of the railways and of the people, have placed their arbitrary wills above the *natural law of railroad intercourse.*

"An ideal transportation system," says Mr. E. Porter Alexander, in his "Railway Practice," "would be one in which any shipper might sit quietly in his office and contract to deliver freight at any town in the United States, by referring to a printed tariff, which should show rates as uniform as the rates of postage and not exorbitant in amount." This ideal system is the postal system, which makes the rate for the shortest distance, for any particular service, the rate for all distances, regardless of amount of business. It is reasonable, practicable, just. Once recognized and adopted as the law of motion in our great circulating system, most of the evils of that system will vanish like the mist before the rising sun.

ELECTRICITY.

Conducted by Franklin L. Pope.

A PARLIAMENTARY committee which was appointed to take evidence and report a bill for regulating the future relations between the electric traction and the telephone systems, particularly in respect to electric interference arising from the mutual use of the earth as a return circuit—a matter which has given rise to more or less litigation in Great Britain as well as in America—has recommended legislation compelling tramway companies to use metallic return conductors of low resistance, and to use all reasonable precautions to avoid interference with telegraph or telephone circuits, or injury to gas or water pipes by electrolytic action. On the other hand, the telegraph and telephone companies are to lose their right of action against the tramways, after the expiration of a certain number of years, if in the meantime they have not done away with the use of the earth as a return circuit. The committee express the opinion that the injuries to gas- and water-pipes which have been complained of are due mainly to a faulty system of construction, and that the difficulty may be practically eliminated by proper attention to the arrangement and construction of the circuits. They further express the opinion that there is in fact but little demand for new tramway lines, and moreover that there is no money in tramways in Great Britain.

CASES sometimes happen in the location of a street-railway in which a very severe grade is unavoidable for a short distance, while the remainder of the line is comparatively level. To meet this condition of affairs a very ingenious device has been invented, and has been for more than two years in successful operation on a line in Seattle, Washington. For a distance of 1000 feet there is a grade varying from 11 to 16 per cent. Two counterbalance weights, aggregating six tons, run on rails laid in a conduit underneath the track. These weights exactly balance an empty car, and are attached to wire ropes running over pulleys. At the top of the grade, on its way down, the car picks up the rope, and in descending hauls the weights up, thus checking its own speed so that the brakes will hold the load without difficulty. At the foot of the grade the conductor disengages the rope by a hand-lever. Going up, the connection is made automatically, and disengaged in a similar manner. A grade of 20 per cent. may be readily overcome by means of this simple and admirable expedient.

THE most extensive attempt to operate an electric street-railway by means of an underground conduit of which we have any knowledge is that which has heretofore been referred to in these notes in Budapest, Hungary. It is now officially stated that 14,000,000 passengers were carried on this road in 1892, as against 8,500,000 in 1891, the net receipts for the last year being sufficient to carry forward a surplus of over $10,000 after the payment of a dividend of 10 per cent. There has been some talk of trying this system in this country, and in view of the above results it would seem well worth while to do it.

A THIRTY-TON electric locomotive recently completed at Lynn, Massachusetts, has been sent to the World's Fair for exhibition. It is intended for elevated or suburban traffic, and is calculated for a normal speed of about thirty miles per hour. It has 44-inch wheels, and a separate motor for each axle. The tractive effort is figured at 6000 pounds. The air-brake and whistle are supplied with compressed air by a special pump driven by an independent motor. The performance of the engine, on trial trips, has proved entirely satisfactory.

AT a particularly dangerous grade-crossing of a steam and electric railway, in the suburbs of Boston, we noticed not long since that a stout team of horses was attached to each electric car and driven over the crossing in front of it. This is by no means an unnecessary precaution. An electric car is far more likely to be stalled on the frogs of a crossing than anywhere else, for the double reason that the electric connection through the track is necessarily imperfect, while the unavoidable bouncing of the car is very liable at the same time to throw the trolley off the wire. Yet we noticed not long since that a court had declined to interfere with the establishment of such a crossing, on the ground that it could be no more dangerous to cross by electric power than by horse-power. That judge will live, it is to be hoped, to see that he has made an error; on the other hand, he may be killed on that very crossing so quickly that he will never have time to suspect that it was his own fault.

THE Brooklyn City Railway Company have completed an immense house for the storage of electric cars. It is built on a hillside, and cars can be run into it from the street-level at three different stories. The main building is 700 feet long and 200 feet wide, contains 6½ miles of track, and is capable of accommodating 1000 34-foot cars at once. Connected with the building are shops for repairs and refitting.

THE electric cars of the Lynn and Boston railway have been fitted with air-brakes, the air being compressed by a pump driven from the axle of the car while in motion. A pressure of about thirty pounds is found to be amply sufficient for the purpose. The brake is so arranged that the motorman can apply it by a pressure of his foot. This improvement will doubtless greatly reduce the number of street accidents.

AS a result of a careful series of experiments, it has been found possible to magnetically screen a dynamo-electric machine to a sufficient extent to permit it to be used for furnishing electric light to the Greenwich observatory, without interfering with the extremely delicate magnetic measurements which are being carried on at that station.

ONE of the ever-present dangers in large electric lighting stations is the possibility of a governor belt breaking or going off the pulley, thereby permitting the speed of the machinery to increase enormously before the engineer has time to shut off steam. Within a few years several serious disasters have occurred from the bursting of large fly-wheels from excessive speed, which in their destructive effects have often been only second to a boiler explosion. W. M. Stine, writing in the *Electrical Engineer*, proposes to arrange a balanced shut-off valve in such a manner that it will be actuated instantly by an abnormal increase in the amperage or voltage of the current. This may be done by means of a small special motor or an electro-magnet, and in other ways which will readily suggest themselves.

A CONNECTICUT manufacturing company has lately completed a search-light having a lens and mirror each five feet in diameter, which is computed to be able to emit a light of 375,000,000 candle-power.

THE city of Allegheny, Pennsylvania, has been lighted for a number of years by clusters of electric arc-lamps placed upon high towers of steel framework. The system has failed to give satisfaction, and the towers are now being replaced with single lights placed upon mast-arms at the intersections of the streets and elsewhere.

IT is stated that 90 per cent. of the vessels traversing the Suez canal go through at night by the aid of the electric light.

ONE of the most interesting historic exhibits relating to electricity, at the World's Fair, is the original working model with which Morse demonstrated the practicability of his telegraph, in a room in the University of the City of New York, on Washington square, in 1837. It will be remembered that Morse was an artist by profession, and this model, crudely constructed by his own hands,—for he was no mechanic,—is made of a canvas frame or stretcher, to which is affixed the wheel-work of an old wooden clock for moving the paper, and a common lead-pencil, moved back and forth by a rude electromagnet for registering upon it the arbitrary signs. When in use, the apparatus was nailed in an upright position to a common kitchen-table. Few who see this machine will be able to guess what it is, without other than intrinsic evidence. It forms a portion of the exhibit of the Western Union Telegraph Company.

A TELEPHONIC circuit for transmitting music, dialogues, etc., from concerts and theaters is in use in Paris, and is said to have more than fifteen hundred regular subscribers. A similar system is about to be introduced in London.

THE city of Stockholm, Sweden, has one of the best systems of telephonic communication anywhere in use. There is one subscriber to every twenty-eight inhabitants, while the annual charge is only the equivalent of $25 of our money. This result has only been rendered possible by the use of a twin-wire system, together with the most modern and improved appliances of all kinds, and the strictest economy in capital expenditure and in operating expenses. The wages of the employés are of course very small. It is estimated that a telephonic system capable of giving thoroughly efficient service can now be established in European cities for less than $100 per subscriber.

THE Pennsylvania Railroad Company have established a long-distance telephone system for the exclusive use of their principal officials, an improvement which is expected not only to secure a greater degree of privacy in communications, but to avoid the necessity of a great deal of tiresome, expensive, and time-consuming travel. The system will be extended south to Washington, and west to Chicago and St. Louis, bringing these and intermediate points into direct connection with New York, Philadelphia, and Altoona.

A REPORT on a set of storage batteries in a private installation, recently made by Professor Weber of Zurich, shows that it is possible, under proper conditions, to attain very favorable results. He found the ampere-hour efficiency of the installation to be 96.5 per cent. and the watt efficiency 82.4 per cent. He gives it as his opinion, after a very extensive experience, that well-constructed, well-managed, and continually active storage batteries will yield on discharge from 92 to 97 per cent. in ampere hours and 80 to 84 per cent. in watt hours. Other investigators have discovered that it is of the highest importance to use both pure water and pure sulphuric acid, and that the slightest impurity has a very great effect on the efficiency of batteries. This is a fact well known to many old telegraph men from their experience with primary batteries used in that service; the writer remembers an instance at Greensburg, Pennsylvania, in which he found it absolutely impossible to maintain a battery in working order which was made up with water taken from a creek in the neighborhood, although upon substituting rain-water, the difficulty vanished at once.

AT a recent soirée of the Royal Society specimens of electrolytic copper were shown by J. W. Swan, exceedingly hard and having a brilliant polished surface like a mirror, which had deposited under a current density of no less than 144 amperes per square foot. This extraordinary result is said to have been attained merely by the addition of a small quantity of colloid matter, such as gelatine boiled in nitric acid, to the ordinary acidulated solution of sulphate of copper. The process is carried out at a temperature of 15° to 20° C., and the current is applied intermittently, 15 seconds on and 15 seconds off, alternately, to prevent the formating of an insulating coating of gelatine. Sheets were shown as thin as paper; they had been stripped from the matrix of bright copper, and were exceedingly elastic, while their surface brilliancy is said to have been marvelous. The same process has been successfully applied to the electro-deposition of nickel, with such excellent results that it seems not unlikely that the scratch-brush and burnisher may hereafter be wholly dispensed with.

AN electric company operating in Portland, Oregon, has arranged a plant for transmitting power from the falls of the Willamette, twelve miles distant, upon a different plan from that usually adopted. Five 40-kilowatt transformers are connected in series at the power-station with a dynamo giving an electromotive force of 1150 volts, which is run at such a speed that the current goes to line with a voltage of 5000. At the sub-station in Portland the voltage is about 4000, and the current is taken off by four similar transformers, also arranged in series.

A SOMEWHAT extensive plant has been erected near Brewster's, New York, where experiments are being conducted with an electro-chemical process of treating sewage. Two vats are employed, in one of which chemicals are mixed with the liquid refuse, which is then conveyed to the other vat, in which movable electrodes agitate the mass and at the same time pass a current from a dynamo-electric machine through it. This produces a violent effervescence, and is claimed to deodorize and disinfect the offensive accumulations. The process appears to be effective, while it has the advantage of being very inexpensive compared with most of the purely chemical systems heretofore in use.

IN the construction of astatic galvanometers and other instruments requiring the delicate suspension of a magnetic needle or system of needles, the cocoon silk formerly used has been almost entirely superseded by fibers of quartz. When properly treated, this material is capable of being drawn into threads of any desired thinness; while in respect to tensile strength, permanence, and freedom from elastic fatigue it is immeasurably superior to any substance which has been tried. Quartz crystals are fused in the oxyhydrogen flame, and the fused material is then drawn out into a rod one-eighth inch thick; this is redrawn by the ingenious method of shooting an arrow into a target from an elastic projector; the arrow is released by a trigger, and carries one end of the quartz thread with it. The thickness of the resulting fiber depends upon the viscidity of the molten quartz and upon the speed and range of the arrow, all of which may be readily regulated at pleasure.

THE decision of Judge Cox of the United States Circuit Court, pronouncing invalid the Faure patent for pasted plates for storage battery cells, will apparently have the effect, if sustained by the Court of Appeals, of substantially terminating the tedious legal controversy in respect to patents which has had such an injurious and depressing effect upon the storage battery industry in this country. The decision practically leaves the owners of the Brush patents in possession of the field so far as pasted plates are concerned.

THE tendency toward the employment of multipolar generators and direct-coupled steam-engines in all large installations is manifestly increasing. By diminishing the armature speed of the dynamo the electrical engineer appears to at last have reached a point where the steam-engineer can meet him under favorable conditions.

IT is suggested by Professor Francis B. Crocker that the thermo-electric couple is by no means so unpromising a subject for further investigation as a possible source of electric energy as usually supposed. Although its efficiency is low,—not more than 2 per cent. at the best,—the simplicity and directness of the operation would seem to render it admirably adapted to the requirements of small isolated plants. Professor Crocker expresses the opinion that, if the same amount of time, money, and scientific ability had been expended upon it that has been expended upon the storage-battery, the thermo-battery would long ere this have been available for many industrial purposes.

IT is much to be hoped that the Electrical Congress at the World's Fair, which will, in all probability, have completed its labors before these lines reach the eye of the reader, will formulate some authoritative definition of the illuminating capacity of arc lamps in terms of voltage and current. The hitherto accepted rating by "nominal" candle-power has no definite meaning whatever, and has given rise to numberless vexatious disputes between municipalities and electric lighting companies. Such an absurdity as this should no longer be tolerated in the present advanced state of electrical science.

MORE than 21,000 patents were granted on inventions involving the industrial application of electricity, between January 1, 1876, and December 31, 1892, and the number of new ones is increasing at the rate of more than 2000 per annum. This annual increase, by the way, is greater than the whole number of patents of this class which were granted from the establishment of the Patent Office down to 1876.

ACCORDING to the Board of Trade returns, the total output of electricity from all the central stations in London, as computed from the meter readings for the last fiscal year, is equivalent to 7,915,746 kilowatt hours, an increase of 84 per cent. over the preceding year. The cost of coal per kilowatt-hour varies in the different stations according to the returns, from a maximum of 4.72 cents to a minimum of 1.84 cents, being apparently, as a rule, greater in the stations employing alternating methods of distribution than in those making use of the direct methods.

A SYSTEM of telephonic control has been established in connection with the street-railway system of Denver, Colorado, which comprises 74 miles of track operated by electricity and 13 miles by cable. The telephone circuits are arranged with various call stations at the termini and junction points of the different routes, all in communication with the dispatcher's office at headquarters. Each conductor is required to report the time of arrival of his car at the end of its outward run, and is informed in return as to his proper time for leaving, and is at the same time given any other instructions which may be necessary. The expense of maintaining a "starter" at these points is thus saved, while a knowledge by the dispatcher of the whereabouts of each car at any particular time greatly facilitates the running of the system in case of the occurrence of a blockade from any cause.

THE returns for the year 1892-93 show a gratifying progress in electrical matters in the city of Berlin. The number of incandescent lamps has increased from 87,763 to 105,094; of arc lamps from 4516 to 5405; and of motors from 430 horse power to 800 horse power. The total output of current for all purposes has risen from 45,990,000 to 53,000,000 ampere hours. The use of motors is said to be rapidly increasing.

THE plant of the Pittsburgh Reduction Company, who have been for some years engaged in the manufacture of aluminum by the Hall process of electric smelting, is being removed to Niagara Falls, where it is to be reëstablished upon a much larger scale. In this process the cost of power is the principal item of expense.

ELECTRIC motors for opening and closing the gates are being applied to the locks on some of the Canadian canals. The power for operating the dynamos is derived from the surplus water at the lock. The new lock of the Canadian canal at Sault Ste. Marie is to be equipped in this way.

A PROCESS of manufacturing varnish from linseed-oil by the action of an electric current has been discovered in Germany, and is said to give remarkably good results.

AN English firm is constructing an engine of 650 horse-power for driving a dynamo for electric lighting. With the cheap gas used it is claimed that the consumption of coal is less than one pound per horse-power hour.

MECHANICS

Conducted by Leicester Allen.

IN type-setting machinery the application of mechanics to the art of printing is reaching a culmination. It is stated that during the last twenty years upwards of $9,000,000 have been expended in bringing the art of setting types by machinery up to its present state. Now, for all plain work, type-setting machines are available. In the London *Times* office a curious arrangement has been adopted for the composition of the stenographic notes of the Parliamentary reporters in the House of Commons, in which type-setting machines play an important part. The stenographic notes are read directly to the operators of the machines, instead of being transcribed, as was formerly the case. Men at telephones in the House of Commons read these notes to men stationed at receivers in the *Times* composing-rooms, who in turn read them to the type-setters. In this way these notes can be set up in type almost as rapidly as they could be transcribed by an expert type-writer; and it is said that the number of errors that creep in are not so numerous as to make the work of correcting proof much greater than by the old system, while a considerable saving in time and expense is effected.

THE straightest thing in nature or art is a ray of light when passing through a medium of uniform density. Hence the eye is enabled to test the straightness of an edge or tube by holding it as nearly as possible coincident with a ray of light, such parts as depart from straightness then intercepting the ray and causing a shade to be cast upon other parts. It is not known at what early period in the history of mankind the discovery was made that straightness could be thus determined. It is certain that thousands of mechanics use the method daily without being able to give a rational explanation of it. This primitive mode of testing straightness, on account of its great convenience and accuracy, is likely to continue in use to the end of the world.

THE recent test of the 12-inch nickel-steel armor-plate at Bethlehem, Pa., by Commodore Sampson of the United States Bureau of Ordnance, was a striking example, not only of the enormous resistance to rupturing stress in steel plates reached by modern metallurgic methods, but also of the tremendous energy developed by modern projectiles through the use of improved explosives. The plate was completely penetrated by a 250-pound Holtzer projectile thrown by a charge of 110 pounds of powder, which pulverized the projectile into small fragments upon its impact with the target. The velocity of the projectile at the instant of striking was 2005 feet per second. To gain a better conception of the tremendous energy represented by these figures they may be reduced to terms of work in foot-pounds. Thus, a projectile of the weight named, moving at the velocity stated, has stored up in it a potential energy competent to the performance of 4,396,910 foot-pounds, or 2198.455 foot-tons. Referring this energy to the weight of the explosive, we find that a pound of the latter must have contained an energy representative of 19.985 foot-tons, or one ounce would represent 1.249 foot-tons. A single grain of the explosive is equal to the performance of 357 foot-pounds of work. These estimates are for net work after deducting losses for windage, friction, and resistance of the air.

THE new anti-friction composition, which has been noticed once in this department under the name of "carboid," continues to attract the attention of mechanical constructors in Europe, and the English engineer, Mr. Killingworth W. Hedges, its inventor, has recently been in this country bringing it to the attention of American manufacturers. He undoubtedly has had to encounter some prejudice due to failures that attended the attempt to introduce a material for which similar claims were made some years ago in the United States under the name of "metalloid." It was claimed for the latter material that it had a lower coefficient of friction without oil or other lubricant than metal bearings lubricated with a good quality of oil. These claims could not be substantiated. The writer once gave a challenge to its promoters to subject the material to the usual approved method of determining coefficients of friction,in comparison with metals then commonly used for bearings, but it was not accepted. Notwithstanding this material failed to meet approval from American mechanics, it did not lack the aid of statements and testimonials from authoritative sources that it was all it claimed to be. Similarly, carboid has the support of high authority for its claims, which, however, are not so extravagant as those that were made for metalloid. Professor Unwin, who has given these claims attention, while not asserting that the coefficient of friction is less than that of well-lubricated metal bearings, yet appears to believe that, for many uses, a material that can be used for dry bearings with as little friction as carboid will be a valuable acquisition to our present stock of anti-friction materials. Among the applications named for which such a material would be especially valuable is included the manufacture of explosives—dynamite, for example—wherein the machinery has to be left working by itself for a period of time limited by the necessity of oiling, which limit would not exist if carboid or other oilless bearings were employed. The composition of carboid is graphite and steatite powerfully compressed, and subsequently baked, the mixture so prepared being amenable to ordinary tools used for working metals, so that it can be planed, turned in a lathe, or otherwise fitted as desired.

It is interesting to note how frequently mechanical ideas revert to abandoned principles, resuscitating them and rehabilitating them. An example of this is found in a car-brake for use on either steam or electric roads, recently announced as the invention of a mechanic in Cohoes, N. Y. The principle of this brake is precisely the same as that of the brake-shoe long in use by wagoners for holding back loaded wagons in descending steep declivities. Hitherto the application of this principle to braking railway-cars has not been successful, although it works perfectly at low speeds, and it may be that the inventor of this brake has been able to obviate the disabilities of the ancient brake-shoe.

Efforts aimed at the prevention of rust in iron work exposed to the action of air and moisture have resulted in the invention of several processes more or less effective for the purpose. It has been found that the formation of a coating of magnetic oxid is, under many circumstances, a considerable protection against the formation of the sesquioxid which is what is commonly called iron rust. The protecting oxid is formed when iron is exposed for a sufficient length of time to the action of highly superheated steam. The renaissance of art in wrought-iron work now in active development in the United States renders any process that will afford more ample protection of special importance at this time. A large establishment has been organized in the city of Brooklyn, N. Y., for the purpose of rust-proofing under what is called the Gesner patent process. This process differs radically from any other that has preceded it. Instead of substituting one oxid as a protection against the formation of another, this process is claimed to transform the surface into a peculiar combination of carbon, iron, and hydrogen, which is permanently proof against the action of air and moisture. Some other peculiar claims are made for this process. It is stated that it renders the metal treated by it capable of remaining proof against rust when exposed to the action of sea-water, earth, or steam condensing upon the surface, the latter being, as is well known, a most effective agent in corroding polished surfaces. It is claimed, in addition, for this new process that it does not increase the dimensions of the article treated, and that the iron is strengthened rather than weakened by the treatment. In fact, some extraordinary claims for increase of strength have been published which it is preferred to not repeat until further opportunity is afforded for their verification.

STILL another method of preserving iron, which is equally applicable to zinc and copper, as well as alloys of the two latter metals, introduced by M. Ghest, of Paris, France, is attracting attention in Europe. The preservation is accomplished by the application of a new composition, which is spread upon the surface by the use of a brush like ordinary paint, and which may be made the basis for subsequent coats of any of the common paints. Thus, after the protective composition is applied, the surface may be ornamented by painting and gilding in the same manner as heretofore. The formula for this composition has not been made public; but the accounts of its properties indicate that, while its preservative action is extraordinary, rendering the metals proof against the action of the strongest acids, it has remarkable flexibility and elasticity, so that metal sheets covered with it may be bent, twisted, or torn asunder, without cracking the coating except at the part where the metal divides. It is said that a brass sheet to which this composition had been applied was subjected to the severe test of first being placed in a sewer for three months, and then being placed in a bath of strong nitric acid, without any perceptible action either upon the metal itself or upon the composition.

STILL yet another process for rust-proofing iron has been invented by Pierre Henry Bertrand of Paris, France, which has for its object the production of a coating of permanent magnetic oxid upon the surface, as in the Bower-Barff process. In this process the oxid is formed by volatilizing a thin layer of volatilizable metal or alloy with which the metal has been previously coated. The coating of the iron to be thus protected by the volatilizable metal is performed by dipping the articles to be treated in baths of solutions of the salts of the coating metals. The protective coating of magnetic oxid is then very easily formed by exposing the articles for about ten minutes in an inclosure heated to 1000° C., and to which air is freely admitted. The rationale of this process, as explained by M. Bertrand, is that the layer of volatilizable metal obstructs the free action of the oxygen in the heated inclosure upon the iron surfaces, the result, instead of being the sesquioxid or common iron rust, being the magnetic oxid. A notable claim made for this process is that it may be followed by enamelling, thus producing very much more durable enamelled ware than has been hitherto possible. In this way, for a period of some two years, the inventor has been manufacturing articles which are claimed to be absolutely non-conductors of electricity; and *The Iron Age*, from which the principal facts in this note have been derived, also states that the process has been successfully applied to cooking utensils, soil-pipes, railings, stable fittings, gas- and water-pipes; the process being cheap, and the time necessary for forming the magnetic oxid and performing the enamelling being less than one hour. Samples of articles thus protected are on exhibition in the French section of the Electricity building at the World's Fair in Chicago.

SINCE the invention of the Globe valve by Nason, the pioneer in the art of steam-heating, many have been the attempts to supersede this beautiful and ingenious device and to improve it. It has been greatly improved since its first introduction, but so far all attempts to supersede it except for some special purposes have failed. Still, among the inventions sought to be patented, improvements in valves form a numerous class. That this is the case is ample evidence that there are faults in all kinds of valves used for controlling flow of fluids through pipes which annoy their users. In properly-constructed globe-valves or gate-valves there need be very little of this kind of annoyance. The trouble lies mostly in the efforts of manufacturers to cheapen valves beyond a point at which a really good valve can be produced. In a large line of globe-valves now on the market there is not sufficient metal to endure the usage to which they are subjected. The seats are so light that they will not withstand the pressure of the screw on their stems when closing them. It is true that it is unnecessary to screw down the disks with great force when the latter are well fitted to their seats. But the fitting is not always perfect, and sometimes dirt or other obstruction prevents perfect closing; and in such cases careless people are wont to screw down the disks with all their force with the intent to close the valve tightly. The result is that the valve-seat is sprung, and until refitted is permanently disabled. Thousands of valves in use, in steam-heating apparatus and in pipes used for other purposes, may be found leaking more or less from this single cause. It is not a sufficient justification on the part of manufacturers to say that they have performed their duty when they have made valves strong enough to just withstand the most skillful manipulation. Valves should be made strong enough to endure the treatment they will inevitably receive, and not merely that which in strictness they ought to get. It is one of the unavoidable contingencies in this class of devices that the majority of them go into the hands of the unskilled and careless.

THE largest power-hammer ever constructed is undoubtedly that of the Bethlehem Iron Company, at South Bethlehem, Pa. The combined weight of the piston, piston-rod, and tup of this mammoth hammer aggregates 125 tons. In a recent issue *The Iron Age* devoted a number of pages to an illustrated description of this magnificent example of mechanical engineering, from which the weights and dimensions are condensed as follows: The foundation for the anvil is constructed in a pit at the bottom of which piles 35 to 40 feet long were driven at intervals of from 2½ to 3 feet. Alternate layers of planking and wood shavings laid upon the tops of the piles support a course of heavy iron blocks. Upon the top of this course is laid a course of planking with intervening cork nailed to the planks, the thickness of this course being 18 inches. Upon this a course of steel bars is laid. Then there is another course of plank and oak, succeeded by a course of heavy cast iron blocks; then more layers of plank and cork; and, lastly, six courses of cast-iron blocks. The estimated weight of metal in the anvil blocks is estimated at 2150 tons. The machine stands 90 feet in height above the surface of the ground, and its total width is 38 feet. These grand proportions may be better appreciated by imagining it to stand in front of a country church of average size, in which position it would hide nearly the whole of the front of the building, and would reach nearly or quite to the top of the steeple.

It is interesting to consider the power that could be delivered by a single stroke of this great hammer. By its own weight, unassisted by the pressure of steam, it could deliver considerably more than 2000 foot-tons, as the stroke is 16 feet and 4 inches. But as the area of the piston is 4536.47 inches, and as steam is carried at 120 pounds per square inch, the pressure upon the piston will be upwards of 272 tons; and if steam be admitted full stroke, the work represented by the steam-pressure would be nearly 4461 tons, making the total work which would be represented by the hammer at its maximum over 6460 foot-tons. In other words, a single blow of this hammer would represent work sufficient to lift a large ship and her cargo one foot in height.

AN interesting display at the World's Columbian Exposition is made by the Consolidated Car Heating Company (Albany, N. Y.), consisting of a model locomotive and train of three passenger cars, the cars being fitted out with the systems of steam heating which this company is now supplying. Everything in this model is completely representative of modern railway progress. The locomotive and tender, aggregating six feet in length, form a working model which is operated by compressed air, for which steam could be substituted if desired, and the cars are fitted up in the most modern style and lighted by miniature electric lamps. Each of the cars is eight feet long, and the total length of the miniature train, including the locomotive, is thirty feet.

An interesting book might be written on the subject of "Evolution in Mechanical Construction," and, should such a book ever be produced, one of its most interesting chapters will treat of the gradual growth into perfect form of some of the most common articles and utensils in daily use among civilized men. Take, for instance, the common barrel or cask for containing liquids. It is evidently a modification of a cylindrical vessel, tub, or tank, probably, in its first form, a length sawed off from the trunk of a hollow tree, and having one end plugged to form a containing cavity when the rude utensil was set up on the plugged end. In oriental domestic use we find this prototype still extant, the hollow trunks of large bamboos forming the cylindrical inclosure. How long it took, after the first resort to this device, for its contrivers to learn that both ends might be plugged and the liquid introduced through a hole in the side and retained there by a third plug driven into the bunghole, is of course impossible to imagine; but centuries probably elapsed before even this advance was made. Then some one had the ingenuity to conceive the idea of constructing a tube of wooden staves bound together by hoops. In the development of this idea, making the tub smaller at one end than at the other in order that the hoops might bind without driving wedges under them probably did not dawn upon the mind of the primitive cooper till the lapse of more centuries. After this the idea of making it smaller at both ends than in the middle and inserting heads in both ends had to be incubated; and this very likely took more centuries. Now consider the result of all this slow growth. The form of an oblate spheroid thus evolved from the plugged bamboo is the most convenient possible for the handling of such substances as are usually put in casks. A well proportioned cask may be turned over endwise—a movement often required—almost as easily as it can be rolled along on its side. And when it is set on end it has a firm base to stand upon,—a great convenience in storing and in transportation. It is light and strong, rivaling in strength almost any other structure of equal weight that can be compared with it. The chine also supplies a most convenient means for grasping with the hands and for attaching appliances for hoisting. In this familiar article we have an example of evolution in mechanical construction that has apparently reached its limit, since no radical change in its general form has been made in it for more than two centuries.

It is well known that the construction of the marine boiler is not favorable to satisfactory circulation of the water in it, by means of which it can be maintained in all parts at the same temperature. The lower parts get several degrees colder than the parts which are over the furnaces, and the colder and heavier water remains there without being stirred up to mix with the lighter and hotter water from which the steam is escaping at the higher level. The consequence of this inequality of temperature is a series of strains upon the shell, which are particularly trying and create a liability to leak at the seams. This leakage is the first step towards that corrosion which is always an element of danger, and which it is desirable to prevent if it is in any way possible. This difficulty gives especial interest to a form of water-heater which is being experimented with at Liverpool, the principal feature of which is that the suction of the feed-pump is taken partly from the hot well of the engine where it has a temperature of 110° to 130°, and partly from the lower part of the boiler under the furnaces. Of course the latter water will be at a temperature higher than 212°, and by suitably adjusting the proportions the water which passes out through the delivery-pipe can be brought up to that temperature. By this means the water in the boiler is compelled to a circulation to supply the place of that withdrawn.

ARCHITECTURE.

Conducted by Barr Ferree.

THE time for the presentation of drawings for the municipal building competition in New York closes on this date, and the hundreds of architects, draftsmen, and students who are supposed to have entered for it will now find time to think of other things. It is simply appalling to contemplate the brain-work these people have performed during the last few months, when in the nature of the case the competitors are for the most part doomed to disappointment. Only six prizes are offered, and, if three or four hundred architects compete, a very simple arithmetical calculation will enable the reader to correctly estimate the number of disappointed ones. While it is scarcely possible that so large a number of drawings will be sent in, it is authoritatively stated that more than five hundred copies of the book of instructions were called for. There is, therefore, every reason to look for an enormous number of drawings, and we respectfully tender our sympathies to the committee that will have to pass on them. The architectural schools have of late years turned out a large number of would-be architects, and this competition has presented an unrivaled opportunity for the best of them to advertise themselves if, by great good fortune, they should secure a prize. It is from these young men, rather than from the older architects, that the most elaborate designs may be looked for. Not that the older men are likely to view the matter with indifference, but the younger element have had larger opportunities to think about the problem at hand, and, coming fresh from the schools, their work is likely to be more *Ecole* in character—and perhaps more impossible in construction—than the work of more matured minds. As to the relative character of the designs that will be offered, it is, of course, impossible to speculate. One or two recent competitions, notably that of the Brooklyn Museum, quite failed to bring out the talent it was hoped would be manifested, and in that competition it was not the best design which succeeded. But at least it is safe to say that our architects and young men—for fresh graduates must necessarily be placed in a class apart from architects who have been practising for years,—have done the best they could. New York ought to have a splendid municipal building, and the prizes have been large enough to attract the very best talent, while the first prize, the building itself, is something the busiest architect may well covet. It may, however, be questioned if the busiest architect is the best man for a building of this kind. A youth fresh from the drawing-class is obviously incompetent, be his design as fine as it may. The building of such a structure necessitates knowledge and experience that is not gained in a four years' course in an architectural school. But the final decision, it should be remembered, rests with the board of building commissioners, not with the judges. The latter make their report, and designate what they consider the order of merit of the drawings, but the final decision is with the city authorities.

THE exhibit of woods contained in the Forestry building is one of the most interesting collections at the World's Fair. The exhibit of woods is extremely fine, and no building compensates one better for a day's study than this somewhat remote and neglected structure. The collections represent wood in all its phases, though perhaps rather more from a forestry standpoint than any other, but the general public, as well as the specialist in woods, and especially the architect, cannot but be interested in the beautiful and complete displays made. It is only of its architectural interests we have occasion to speak, but the general bearing of the collections should not be overlooked. The contents of this building are notable in forming one of the few complete displays in the exposition. The woods are shown by countries and by States,—most of the timber-bearing States being well represented, and the foreign exhibits including Japan, Mexico, Argentina, New South Wales, France, and other countries. The foreign displays are not especially noticeable, most of them being small in extent, and the majority of woods being tropical or ornamental species not obtainable in this country. Of these special mention may be made of some very fine boards, having an exquisite polish, from New South Wales. These are of great size, and, if obtainable in marketable quantities at fair prices, should be excellent for interior work. A beautiful purple wood from Trinidad—the "purple heart"—should also be mentioned as among the most striking specimens shown. But the displays of native woods are more interesting. First of all, they are very complete, being supplied with ample labels, and shown in sections and finished with polish. The New York display, supplemented with transparencies and large photographs of trees in their native state, is especially notable, though similar photographs are shown by other States. Several States also show practical examples of their wood products as applied to buildings in manufactured products, screens, doors, panels, counters, etc., all arranged with good taste and showing the varied woods of the States to the best advantage. One or two private firms likewise exhibit finished products, the Southern Lumber Manufacturing Co., for example, having large rooms wholly finished in wood. The great merit of the collections in the Forestry building is their completeness, both as to variety of exhibits and for the ample information given the public. It is one of the few buildings in which any one, whether familiar with the subject or not, may really learn something from examining the exhibits, and that without having to trouble an attendant with questions. This is a tremendous advantage, and it is so exceptional as to call for special comment. The chief of the department and his assistants, as well as the individual exhibitors, are to be congratulated for the thoroughness with which they have performed their task.

It is a matter of more than ordinary regret that the same care was not taken with the other departments allied to architecture. For the present we are only concerned with the architectural collections at the Fair, and hence look at it through architectural spectacles. The department of building materials is one of which much might have been expected, in which the individual exhibits make a goodly number collectively, and of which information is as hard to get as a Philadelphia spring chicken in the lanes and cowpaths of that rural city. At first thought, perhaps, no architect would think of looking for anything that concerned him professionally in the Mines and Mining building, and perhaps this is one reason why the larger part of the exhibits of building stones, clays, and the like, were put there. Whatever the reason, there they are, and, if one would care to see a nice lot of stones, carefully labelled, in most instances, with their name and place of origin, no better place to examine such a display could be imagined. The collection, taken as a whole, is a fairly large one. As usual, the foreign exhibits are practically *nil*, and the honor of making the major part of the display therefore rests upon the United States. Neglecting the foreign collections altogether, the exhibits may be roughly divided into two groups, those made by the States and Territories, as part of their State exhibits, and the collection made under the direction of the department of Mines and Mining, and which is located in one of the galleries of that building. The latter may be considered first, for, when its origin is taken into account, it might naturally be supposed to be the most valuable. And so it doubtless is, since the specimens are arranged with great care and nicety, and each is distinctly marked with its place of origin and its name. This is very well as far as it goes, but the inquiring architect who may wish to find out something about these stones, who may wish to compare the similar products of different vicinities with a view to preferring one stone to another, in a word, one who wishes to find out anything about the structure of the stones, their power of resistance, wearing qualities, and the like, all of which are of vastly more practical value than the common or scientific name, will find it quite impossible to gain any knowledge, either from the specimens themselves or from the chief of the department. The collection is simply a nicely arranged collection of cubes of various colored stones, pretty to look at, of some value, perhaps, to a college, where they could be handled and studied, and where their properties could be ascertained, but absolutely worthless as illustrations of the resources of this country in building stones.

DOWN-STAIRS, on the main floor, things are not much better. The collections here are in the charge of the different States, and, if one's intellect can survive the sight of the horrible silver statue that is placed in the center of the Montana exhibit,—and which, by the way, is the center of a vast crowd every day, though the horrors of this silver image is apt to be forgotten in its monetary value,—one may see a tolerably large collection of building stones. But information is no freer on the main floor than on the gallery; in fact, things are, if anything, a little worse, since the very attendants here glory in their ignorance. Several States make very good shows. New York is one of these, the collection being large and fine, generally well arranged, but without any structural information. Pennsylvania likewise has quite a collection, even less instructive than that of its great neighbor's. One or two States have enclosed their displays in pavilions built from their own building-stones, a very good idea, though such an arrangement would have been more satisfactory in the open air. In this respect Ohio, which has a large collection at Chicago, made a better showing at Philadelphia, where an entire house, built of various Ohio building-stones, was erected on the grounds. There is, therefore, very little to chronicle in connection with this display, save to regret that it had not been made of greater educational and practical value, and been really useful to the architect and builder, as it was, in idea, intended to be. The entries in the catalogue, coming under this head, make a formidable showing, but, while it would be grossly unfair to say that every stone has been catalogued, the difference in volume between the actual exhibits and the space in the catalogue forcibly impresses one.

THOUGH the display of foreign building materials and appliances of any sort is extremely limited in the Mines and Mining building, some few exhibits belonging to this department may be seen in the Manufactures and Liberal Arts building. As might be expected, most of these collections consist of ornamental stones and marbles. New South Wales is an exception in this respect, her exhibits including not only marbles and costly stones, but the more common sorts of granites, sandstones, and the like. This collection is rather more valuable as illustrative of the resources of the colony than it is likely to be as a stimulant of importation into this country. The United States is so amply provided with building-stones of the more ordinary kind that we do not need to look to Australia for such materials. But the fullness of the collection from New South Wales deserves commendation, not only because it is the only British colony making any attempt at a serious display at the Fair, but because it indicates a very commendable industry and energy. A notable part of this display consists of blocks of marble, taken from various quarries, and shown in blocks of good size. These quarries have not yet been much worked, and hence the samples shown, we are informed, do not represent the best grades that can be obtained from them. But even as they stand the range of colors—pink, white, black and white—is fairly good. Next to these, perhaps surpassing them in interest and in beauty of arrangement, is the display of marbles made by the Société Anonyme Merbes-le-Château, of Belgium, which make a very fine display, beautifully arranged in panels of equal size, of marbles of the most varied colors. Though this collection occupies only a relatively small amount of wall space, it is well worth looking at. The Belgium section also shows some small collections of black marble of fine surface. Few other countries make any contributions to this department, scarcely more than a single collection or group of stones being attempted in any case. Mention might be made of the pyramid of marbles of various colors shown by Chr. Anker, Fredrikshald, Norway, and of the collection of syenite granites by Erik and Gude, of Christiana, Norway, of which an "emerald and blue-pearl" variety is the most striking.

THE ornamental side of architectural construction as represented in materials is not very well shown at the Fair. Quite a number of firms, both foreign and American, make exhibits of tiles, and the volume of these is quite considerable. The most satisfactory thing in connection with these collections is the very marked and evident progress our own manufacturers have made since the Philadelphia Centennial. There are many other departments, of course, in which the same satisfactory comparisons may be made, but this is one of the most notable advances in artistic progress in this country. Tiles, and chiefly decorative tiles, are the most important contributions to the building art made by foreign exhibitors. Several well-known English firms are well represented, and the average quality of the displays is generally good. In France the most important exhibit in this collection is that made by Emile Muller et Cie., of Ivry-Port, near Paris. This firm shows a large collection of architectural work in faience and stoneware, arranged with the taste and skill of which the French are most eminent masters. A large part of this exhibit consists of a reproduction of the famous "Archers' Frieze" from Susa, Persia, now in the museum of the Louvre. This is one of the most splendid pieces of ancient tile work that has survived to modern times, and, while the present reproduction is scarcely likely to have any special commercial value, it serves excellently well for displaying the resources and ability of the Muller products. More striking than either the French or English display of tiles is that of Germany. This is due to two causes, first, because much of it is hopelessly bad, and, secondly, because a large portion of the display is on the main aisle, where its brilliant coloring and prominent position ensure universal attention. The most objectionable part of this display, and it is more extensive than that of either England or France, consists of series of large tile pictures, the subjects of which vary from the allegorical to the historical. The most that can be said in favor of these things is that they form an effective background for the displays of china and porcelain placed in front of them, but they are without any artistic value, and quite useless to the architect.

THE most important architectural event of the past month was the holding of the International Congress of Architects at Chicago. Rather it should have been the most important event. As it was, it was only rescued from completest failure by the energy of the president and secretary of the American Institute of Architects, who merged their own splendid program of papers and addresses into the proceedings of the Congress. By this means the latter body assumed an appearance of respectability and energy to which the labors of the committee having it in charge contributed practically nothing. After more than a year's work this body only produced eight papers, three of which were by American contributors. We do not hesitate to refer to this failure, since with properly directed energy the International Congress might have been made successful without the help of the Institute. The whole matter properly belonged to the latter body, but, an independent organization having assumed charge of it, it should have carried its work through to the end. The first week in August was not a good season at which to hold the Congress, though the Engineering Congresses, held at the same time, were, as is the case with all public meetings of engineering societies, completely successful. August is not the best time in the year to visit Chicago, and many architects, especially the younger ones, were busy completing their plans for the new municipal building competition in New York. This enterprise has just closed, and the first week in September is likely to see more architects in Chicago than were assembled in that city during the first week in August.

THE Department of Architecture is extremely glad to tender its heartiest congratulations to the American Institute of Architects, and especially to President Kendall and Secretary Stone, for the very interesting and extended program they procured for the convention of the Institute, and which, through their courtesy, become the larger part of the proceedings of the Congress of Architects. This generosity in thus giving away the largest and most varied program ever presented by the Institute deserves the heartfelt thanks of all architects as well as of the more general public that takes an interest in this great art. The Institute programs have been so usually devoid of interest in the past, the value of the meetings and of the interchange of professional intercourse has been so little understood and appreciated by the profession, that this new departure by the Institute, for which Mr. Stone is chiefly responsible, is the more satisfactory and the more to be commended. The papers read at the Congress covered a wide variety of subjects. The most notable were unquestionably a group of papers prepared by the architects and engineers of the Exposition, giving for the first time an authoritative and professional view of the organization of the Exposition and the work done by those responsible for it. Of the vast quantity of matter that has been written on this subject these papers are likely to remain the most valuable. The papers in this group covered all the more important architectural and engineering features of the Fair so far as the work of organization was concerned. The other papers, which comprised the larger part of the program, were also interesting and valuable, though not quite in the same way. The variety of subjects, as the printed program shows, was sufficiently large to interest almost every architect, and the range of papers indicated a most healthy diversity of thought among the members. Reference to some of the more important of these must be deferred to future issues of the Magazine; meanwhile we will content ourselves with expressing the hope that the literary activity manifested in the architectural profession, as indicated by the program of the recent Convention of the Institute, will mark the beginning of a new era of professional activity in that body, which will mean an increased usefulness to the members professionally as well as to the general public. The latter, in some respects, are more important than the architects, since without the public the architects could not find business to support life. Every step which widens the interest of the general public in architecture in any or all of its branches is a step forward in the practice and elevation of architectural art.

MINING AND METALLURGY.

Conducted by Albert Williams, Jr.

THE international Engineering Congress which assembled at Chicago on July 31 was a notable one. Prominent among its sections were division C of mining engineering and division D of metallurgical engineering, both being in charge of the American Institute of Mining Engineers. The list of papers read embraces many on important subjects by distinguished engineers. Among the representatives from foreign countries may be counted some of the best-known authorities in the mining and metallurgical professions, while of course the American members of the Institute turned out in great force to welcome their guests. These international gatherings of professional men, yearly becoming more frequent and better attended, are not only of considerable scientific and technical importance, but tend also to encourage the world-wide feeling of good-fellowship, mutual interest, and generous rivalry which ought to, and does, prevail. The whole tendency of the times is toward the freest interchange of information and opinion, a policy much more sensible and progressive as well as more liberal than that of keeping "trade secrets"; while the social features of these conclaves cannot be too highly esteemed.

IN a description of the Turkey Heaven gold district, Alabama, Mr. W. M. Brewer calls attention to a method of construction adopted in a small stamp-mill lately built there, in which the batteries are so placed as to have no direct connection with the floor and walls of the building, thus avoiding jarring and allowing of a lighter and cheaper construction of the latter, because there is no vibration to rack the framework. The plan is not new, but is seldom carried out to the fullest extent. All stamp-batteries have independent foundations, the mortar bed resting on heavy vertical timbers set like spiles, securely bound together and usually surfaced with some deadening material on which the mortar rests, while to still further ensure solidity sometimes special preparations, as melted sulphur, are run into the timber ends. But all this is of little avail to prevent outside vibration if the struts to the battery frame connect with the timbers of the building itself. Besides the question of independent stability of the batteries and the building, it is important that the other apparatus, especially that requiring nice adjustment, should be free from unnecessary vibration. Mr. Brewer also mentions a method used in hanging the lower ends of the plate frames by adjustable hooks, thus permitting a ready change in inclination of the plates. This, too, is a good idea.

THE export duty on bullion from the peninsula of Lower California was advanced on July 1 to $75 per $1000, or 7½ per cent. Formerly it was about 3 per cent. The Mexican policy of taxing exported bullion has certain practical reasons for existence, among them the convenience of collection; but it has a deterrent effect upon mining, and the increase in the present instance will be severely felt by the mining industry of the peninsula, which, in spite of the many good mines, has already had sufficient natural disadvantages to contend with.

A SMALL riot occurred at Leadville, Colorado, on August 3, caused by a horizontal reduction in wages at the Arkansas Valley smelting-works, one of the largest reduction plants in the West. Some of the men accepted the proposed terms and went on shift as usual, but were driven off by the dissatisfied ones, with threats and some actual violence. Then the works closed down. Everywhere retrenchment is the order of the day. It is not the fault of the managers of mines and reduction-works that a considerable part of this retrenchment must fall upon labor, though there is a perverse feeling among many employés that the hard times are made an excuse for reducing wages. This idea is unwarranted. It is a matter of necessity, not choice, under present conditions.

ALL the silver-mining camps are full of idle men, most of whom have been thrown out of employment by the closing of the mines on account of the low prices for silver. In some cases, however, the men had a chance to continue work at reduced wages, $2.50 a day for miners being offered usually; but they almost invariably declined to accept the reduction, whereupon the employers, who might have continued operations had the men been willing to meet them half way, have closed their mines also. The result of this mistaken policy on the part of the miners is that thousands of them cannot now get employment at any wages whatever, and much perhaps unnecessary distress has been the consequence.

LAKE SUPERIOR iron-mines have suffered severely during the recent general depression in almost all industries, though less complaint has been heard of this than of the sudden decadence of silver-mining, and far less attention has been given it. In the various iron-ore districts collectively known as "the Lake" some large mines have been forced to suspend, at least until stocks on hand should be exhausted, and this too in the midst of the shipping season. The number of men thus thrown out of work was large.

THE jury of awards in the Mining department of the World's Columbian Exposition perfected its organization in the last week of July, with the following officers: President, Mr. Henry M. Howe, of Boston; vice-presidents, Messrs. de Zellenkoff, of Russia, and Lundbohm, of Stockholm; secretary, Mr. J. D. Weeks, of Pittsburg. Among the prominent names on this jury are those of Professors LeNeve Foster and Bauerman, of the Royal School of Mines, London; Signor Capacci, of Florence, Italy; Mr. Odelstjerna, of Sweden; Professor White, of the University of West Virginia; and others. The work of judging exhibits was begun at once.

THE mineral production of Great Britain in 1892 was in the aggregate lower than in 1891. Coal fell nearly 3,750,000 tons to 184,751,629 tons; iron ore, about 1,500,000 tons to 11,497,456; and most of the other mineral products, with the exception of zinc ore and a few minor minerals, declined proportionately. The foregoing quantities are stated in metric tons (2204 pounds). The list of minerals reported in the British statistics as of domestic production includes alum shale, arsenic, arsenical pyrites, barytes, bauxite, clays, coal, copper ore, copper precipitate, fluorspar, gold ore, gypsum, iron ore, iron pyrites, lead ore, manganese ore, ocher and umber, oil shales, phosphate of lime, salt, slates, sulphate of strontia, tin ore, wolfram, and zinc ore. Besides the many mineral products of home production, the United Kingdom imports largely from foreign sources; while it exports coal, salt, and a few other mineral substances.

CALIFORNIA gold-mines are now producing considerably over $1,000,000 a month; and the *Mining Press* (San Francisco) thinks that there is promise of a decided increase during the rest of the year. Since the cessation of silver mining elsewhere an impetus has been given to gold mining in California, as in other States and Territories, that is destined to augment the product. As the *Press* justly says, California has by far the largest and most productive gold-mining area in the United States. Good "running" gold-mines are comparatively scarce and are in demand. They are hard to find for purchase, as those who own them hold on to them. The *Press* thinks that the smaller claims and prospects are what will have to be taken up by investors in search of gold properties.

EFFORTS are being made to reduce expenses in operating the mines of the Comstock lode, of Nevada. There has always been room for reduction of the office expenses of these mines. It is stated that the railroad and the water people have agree to cut down their charges, and the wood people, whose profits are small, have agreed to reduce as much to the mining companies as the railroad will reduce to them. The way the matter now stands, it depends upon the miners' union to meet all the other interests. A 25-per cent. cut in the salaries and wages all around was the proposition of the operators. Such large interests are at stake in the continuance of work on the Comstock—not only the direct investments in the mines and mills, hut also those in the transportation, and the timber, fuel, water, and other supplies and adjunct industries—that every endeavor has been made to keep the mines going. It should he remembered that a large proportion of the total value of the product is in gold, that proportion increasing with the decline in the value of the silver.

THE numher of men directly involved in the great strike of the English coal miners, which hegan toward the close of July, is stated at ahout 350,000. The English coal miners, like the miners in various districts of this country, chose a peculiar time to inaugurate a strike, just when the general business depression and the need for retrenchment in all directions were against them.

THE great decline in the market value of mining plant in Utah has caused the representatives of insurance companies to withdraw from the mining camps of that Territory, and, it is hinted, to curtail risks on mining property and in mining camps throughout the silver-producing region of the far West. The insurance companies are said to be refusing to renew policies, at least on the former terms.

NOT to he behind their comrades elsewhere, the miners working in the collieries of Nanaimo, British Columbia, lately went on strike. The cause was a proposed reduction of 20 per cent. in wages. Subsequently a compromise on a 10 per cent. reduction was effected.

RUSSIA'S gold production in 1892 was 38,822 kilograms, against 36,310 kilograms in 1891, showing an increase of 2512 kilograms. The 1892 output would be worth, in American money, $25,801,101. This gold comes from a number of widely separated districts, and not mainly from the Urals, as generally supposed. At present the Irkutsk district in eastern Siberia is the principal source.

THE name of a new corporation is the Woman's Gold Mining Company. It has $800,000 (nominal) capital. Its directors are all of the irresistihle sex. The property is at Cripple Creek, Colorado. If the directors' meetings are to be frequent, and as animated as those of the hoard of lady managers of the World's Fair, there will be a sufficient outlet for the energy of the company to preclude the necessity of utilitarian earth-gruhhing. There is a law against the employment of females (hase word!) underground in mines. It does not specially forhid the descent of female superintendents or forewomen, certainly not of visiting lady directors. This is a new extension of woman's field of usefulness, the outcome of which will be watched with interest.

SEVERAL recent locations of borax claims have recently heen made in the Calico mountains, in the arid region of southeastern California. They are said to be very rich and that samples run 75 per cent. of the salt. It is not generally understood how important the borax industry of California and Nevada is and has been. In resources and output it outranks all others in the world. The production is over 11,000,000 pounds annually, worth seven and a fraction cents a pound, spot.

NOT to excite the minds of possihle investors, or boom the property hy specifying, the name and locality of a gold mine reporting an "extensive" strike of $100,000 ore are not here given. The best ore, in any quantity, that the writer has ever seen ran about $300,000 a ton. There were perhaps a hundred pounds of it,—say $15,000 worth. The mine that produced it was offered for sale at $60,000, which means that, if it would yield just one solitary ton of similar ore in all its future history, it would return $240,000 gross to the buyer. In the present case it is quite likely that $100,000 gold ore was struck; that is, a nice little pocket-piece. But "extensive" is too much. A $30-a-ton gold mine of any size is a bonanza; and a big deposit, favorably situated, may run way below $5 a ton and be another Alaska-Treadwell or Homestake.

THE South American mining exposition will open March 15, 1894, at Santiago, Chile. It will be an exhibition of mining and metallurgical appliances, and should be taken advantage of by American manufacturers who are interested in the export of such machinery. The undertaking is in charge of the Sociedad de Fomento Fabril; and the secretary of that society, Señor Julio Perez Canto, at Santiago, may be applied to for information.

ACCORDING to the *Moniteur Industriel*, the engineers of the principal coal mines of the north, in France, are studying the application of aluminum to the manufacture of cages, cables, etc. The difference in weight between aluminum and iron and steel is considerable, and consequently the use of the former would increase the load capacity; on the other hand, the continuous lowering of the price of the metal renders its use possible. While it is possible that the use of aluminum as the material for certain mining apparatus or parts of apparatus is feasible, it is doubtful whether, in the present stage of aluminum metallurgy and manufacture, engineers would care to rely upon hoisting cables made of aluminum. Steel wire, either in round laid or flat woven cables, is an extremely reliable material, and one knows exactly what to expect of it; while in any event it will probably be a long time before aluminum manufacture has so advanced that the same reliance can be placed upon it. Weight for weight, the steel cables would now be preferred. Accidents from their breakage are extremely rare. The increased diameter of equivalent aluminum cables would be a disadvantage, while their non-corrosibility would be in their favor.

A NEW form of respirator, known as the Guilbert *apparatus respirateur*, has been tested, it is said successfully, in the gaseous coal mines of France, England, and Germany, and is on trial in this country. The apparatus was invented originally for the use of the fire departments of France, to be worn by firemen who enter buildings filled with smoke and gases in order to rescue inmates or property. It was then tried in gaseous mines, and, if it comes up to the claims made for it, will be very serviceable in the saving of life in fiery mines and rescuing victims of mine explosions and fires. The suit, as it is called, consists of a piece for the mouth and head and an air reservoir carried on the back, the air chamber being connected with the mouth and nostrils by a rubber tube, and the wearer regulating the supply of air as needed. The description given does not state whether the air is compressed, which it probably is, as has been proposed in other similar inventions. A portable incandescent electric lamp goes with the respirator, and is attached to the lappel of the coat, being fed by a small battery carried at the waist.

PORTABLE electric mining-hoists now on the market and in actual service are recommended as convenient for use in tunnels for winze work, and for prospecting purposes at a distance from the central stations. They are mounted on wheels for moving about on temporary work, though adapted to permanent service as well. This feature of ready portability is also exemplified in the electric pumps which are being introduced.

CALCULATION shows that by the use of aluminum wherever practicable in the arms and accouterments in the German armies the weight to be carried by the infantry soldier will be reduced from 68½ pounds to 57 pounds.

THE TECHNICAL INDEX.

A CATALOGUE OF LEADING ARTICLES PUBLISHED CURRENTLY IN THE TECHNICAL JOURNALS OF THE UNITED STATES AND GREAT BRITAIN.

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[In the body of the Index only the initials of the journals quoted are given, and these can be readily identified by the following list of periodicals. Other abbreviations are: Ill=illustrated. W=words.]

THE AMERICAN PRESS.

A........Arena. *m.* $5 per year. Boston.
AA.......American Architect. *w.* $6. Boston.
An A A..Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
A An.... American Analyst. *f.* $1 per year. N. Y.
A Ar.....American Artisan. *w.* $2. Chicago.
A & B....Architecture and Building. *w.* $6. N. Y.
A B M...Architect, Builder, and Manufacturer. *m.* $1.50. Kansas City, Mo.
A CJ....Am. Chemical Journal. *b-m.* $4. Baltimore.
A D... ..American Druggist. *m.* $1.50. New York.
A E .....Architectural Era. *m.* $3. N. Y.
A G......Am. Geologist. *m.* $3.50. Minneapolis.
A G L J..Am. Gas Light Journal. *w.* $3. New York.
A H......Annals of Hygiene. *m.* $2 per year. Phila.
A J Phar.Am. Journal of Pharmacy. *m.* $3. Phila.
A J R A..Journal of Railway Appliances. *m.* $2 per year. New York.
A M......American Machinist. *w.* $3. New York.
A M & I W.American Manufacturer and Iron World. *w.* $4 per year. Pittsburg.
Am A....American Agriculturist. *m.* $1.50. N.Y.
Am G....American Gardening. *m.* $1. N. Y.
A M M...American Mechanics. *m.* $1. Minneapolis.
Am M....American Miller. *m.* $2. Chicago.
Am S....American Shipbuilder. *w.* $2. N. Y.
A & N J..Army and Navy Journal. *w.* $6. New York.
A & N R..Army and Navy Register. *w.* $3 per year. Washington.
A R......Architectural Record. *q.* $1. New York.
A Rev....Architectural Review. *s-q.* $5. Boston.
A S .....Age of Steel. *w.* $3. St. Louis.
At M.....Atlantic Monthly. *m.* $4 per year. Boston.
B B......Brick Builder. *m.* $2.50. Boston.
B C......Boston Commonwealth. *w.* $2.50.
B & D....The Builder and Decorator. *m.* $2. Minneapolis.
B G S .. Bulletin of the American Geographical Society. *q* $5. N. Y.
B I S.....Bulletin of American Iron and Steel Association. *w.* $4. Phila.
B J C....Boston Journal of Commerce. *w.* $3 per year. Boston.
B P .....Bulletin of Pharmacy. *m.* $1. Detroit.
B & W...Builder and Woodworker. *m.* $1. N. Y.
C........ .Compass. *m.* $1 per year. New York.
C A......Calif. Architect. *m.* $3. San Francisco.
Can A...Canadian Architect. *m.* $2. Toronto.
C & B... Carpentry and Building. *m.* $1. New York.
C B T....Builder and Trader. *w.* $2. Chicago.
C E .....Colliery Engineer. *m.* $2. Scranton, Pa.
C E N....Canadian Electrical News. *m.* $1 per year. Toronto.
Ch.......Chautauquan. *m.* $2. Meadville, Pa.
C M......Century Magazine. *m.* $4 per year. N. Y.
Cos.... ..Cosmopolitan. *m.* $3 per year. New York.
D E......Domestic Engineering. *m.* $1. Chicago.
D J... ..Drainage Journal. *m.* $1. Indianapolis.
D Jour. .Druggists' Journal. *m.* $1. Chicago.
E A......Electrical Age. *w.* $3 per year. New York.
E E N Y..Electrical Engineer. *w.* $3 per year. N. Y.
E I.......Electrical Industries. *m.* $3. Chicago.
E M......Engineering Mechanics. *m.* $2. Phila.
E Mag...Engineering Magazine. *m.* $3. New York.
E M J....Engineering and Mining Journal. *w.* $4 per year. New York.
E N......Engineering News. *w.* $5 per year. N. Y.
Eng......Engineer. *s-m.* $2 per year. New York.
E N Y....Electricity. *w.* $2.50. N. Y.
E P D....Electrical Progress and Development. $2. Boston.
E R......Engineering Record. *w.* $5. N. Y.
E & R ...Electricity and Railroading. *m.* $1 per year. Boston.
E R N Y..Electrical Review. *w.* $3 per year. N. Y.
E W......Electrical World. *w.* $3 per year. N. Y.
F ....Forum. *m.* $5 per year. New York.
F D......The Foundry. *m.* $1. Detroit.
F M......Farm Machinery. *m.* $1. St. Louis.
F W .....Fire and Water. *w.* $3 per year. N. Y.
G & F....Garden and Forest. *w* $4 per year. N.Y.
G G M...Goldthwaite's Geographical Magazine. *m.* $2 per year. N. Y.
G R......Good Roads. *m.* $2 per year. N. Y.
I A......Inland Architect. *m.* $5 per year. Chicago.
I Age....Inventive Age. *s-m.* $1. Washington.
Ir Age..Iron Age *w.* $4.50. N. Y.
I R W...India Rubber World. *m* $3 per year. N. Y
I S F.....Industry. *m.* $2 per year. San Francisco.
I T R....Iron Trade Review. *w.* $3. Cleveland.
J A . ..Journal of Architecture. *m.* $2. Phila.
J A C S..Journal of the American Chemical Society. *m.* $5 per year. N. Y.
J A E S..Journal of the Association of Engineering Societies. *m.* $3 per year. Chicago.

J F I.....Journal of the Franklin Institute. *m.* $5 per year. Philadelphia.
J M S I..Journal of the Military Service Institution. *b-m.* $4 per year. Governor's Island, N. Y. H.
J N E W.Journal of the N. E. Waterworks Association. *q.* $2. New London, Conn.
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L F M...Locomotive Firemen's Magazine. *m.* $1. Terre Haute, Ind.
L M......Leather Manofacturer. *m.* $3. N. Y.
L Mag...Lippincott's Magazine. *m.* $3. Phila.
L P ......Louisiana Planter. *w.* $3. New Orleans.
M & B...Manufacturer and Builder. *m.* $1.50. N. Y.
M & El...Mechanic and Electrician. *w.* $2 per year. St. Louis.
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M G......Manufacturer's Gazette. *w.* $2.50. Boston.
Min......Minerals. *m.* $1 per year. N. Y.
M I T....Mining Industry and Tradesman. *w.* $3 per year. Denver.
M N.....Mechanical News. *s-m.* $1.50. New York.
M R......Manufacturer's Record. *w.* $4. Baltimore.
M R C...Marine Review. *w.* $2. Cleveland, O.
M Rec....The Marine Record. *w.* $2. Cleveland.
M S P....Mining and Scientific Press. *w.* $3 per year. San Francisco, Cal.
M S R....Mining and Scientific Review. *w.* $2 per year. Denver.
N A R...North American Review. *m.* $5. N. Y.
N B ......National Builder. *m.* $3. Chicago.
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O P D R..Oil, Paint and Drug Reporter. *w.* $6. N.Y.
P.........Paving and Municipal Engineering. *m.* $1 per year. Indianapolis.
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R M.....Roller Mill. *m.* $2. Buffalo, N. Y.
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*10800. Inaugural Address of C. C. Carpenter (G W–Feb. 18.) 6500 w.

*10824. Cooking-Gas at Copenhagen (J G L–Feb. 14.) 1600 w.

*10825. The Use of Air for the Purification of Gas. Norton H. Humphreys (J G L–Feb. 14.) 2100 w.

10865. The Gas Engine (Sc A S–March 4.) 700 w.

10929. Effects of the Trolley System on Gas and Water Pipes, with Discussion. H. A. Allyn (A G L J–March 6.) 5400 w.

10930. Recording Pressures on Mains and Services, with Discussion. S. J. Fowler (A G L J–March 6.) 5600 w.

10931. The New Plant of the Altoona (Pa.) Gas Company. T. W. Cole (A G L J–March 6.) 1500 w.

*10987. A Look into the Distribution Department. Paulos Thieman (G W–Feb. 25.) 5400 w.

HYDRAULICS

†10523. Mr. Doig's Report on the Shone System at Rangoon. Xen (I E–Jan. 14.) 550 w.

†10524. Sanitary Engineering in India. Pump (I E–Jan. 14.) 500 w.

10541. Reduction of Water Consumption by Meters (E N–Feb. 16.) 1700 w.

*10544. Presidential Address of W. A. Valon (J G L–Feb. 7.) 7500 w.

10548. New England Water Power (P M–Feb. 16.) 800 w.

†10583. Artesian Waters in the Arid Region. Ill. Robert T. Hill (P S M–March.) 4300 w.

*10633. Discussion of William Matthews' paper—"Description of the Pumping Engines and Water Softening Machinery at the Southampton Water Works" (E–Feb. 10.) 5000 w.

*10654. The Jet Water Wheel. C. R. Tompkins (Am M–Jan. 1.) 1000 w.

10729. Niagara Must Go to Work (P M–Feb. 23.) 900 w.

10752. The Formation of Sand Filters. Ill. (E R–Feb. 25.) 2000 w.

*10785. Joseph Moore's Patent Hydranlic Pumping Arrangement (C G–Feb. 17.) 2000 w.

*10806. Water Power of the Periyar River (E–Feb. 17.) 900 w.

10877. Niagara Falls in Harness (P A–March 1.) 2000 w.

10897. The Discharge of the Niagara River. Ill. (E N–March 2.) 3400 w.

*10906. The Dam and Power at Holyoke, Mass. Ill. (R M–Feb.) 1200 w.

10969. The Irrigation Qnestion from a Botanical Standpoint. Frederick Vernon Coville (E M J–March 4.) 1000 w.

11072. Hydraulic Reaction Motors.—Abstract of paper by De Volscn Wood (A M–March 9.) 1300 w.

11074. The Hydro-Electric Distribution of Power and Electric Energy. Ill. E. Hospitalier (Sc A S–March 11.) 1700 w.

11088. A Water Filtration Plant at Leeuwarden, Holland. Ill. (E N–March 9.) 900 w.

Serials.

9998. American Turbine Water-Wheels. Ill. Samuel Webber (Ir Age–Began Jan. 26—Ended March 2—5 parts—15 cts. each).

10988. Water-Power Utilization. Ill. W. H. Booth (E L–Began Feb. 24—1 part to date—30 cts).

INDUSTRIAL CHEMISTRY.

*10627. The Distillation of Coal. Pierre Mahler (C G–Feb. 10.) 350 w.

*10744. The Manufacture of Nitric Acid (I L–Feb. 17.) 1800 w.

*10827 Note on the Purification of Mercury. Ill. M. W. Jaeger (E R L–Feb. 17.) 800 w.

†11057. The Effect of Decomposing Matter on Natural Phosphates. N. T. Lupton (J A C S–Dec.) 1600 w.

11062. Carborundum:—Its Manufacture and Use. Ill. E. G. Acheson (E E N Y–March 3.) 2000 w.

Serials.

11049. The Applications of Ozone (E R L–Began Feb. 24—1 part to date—30 cts).

INDUSTRIAL SOCIOLOGY.

*10500. The Industrial Problem in Australia. Ill. Edmund Mitchell (E Mag–April.) 3000 w.

*10503. Fallacies and Facts as to Immigration. John B. Weber (E Mag–April.) 3000 w.

*10504. The Dearness of "Cheap" Labor. David F. Schloss (E Mag–April.) 3000 w.

10579. Wages. Editorial (A M M–Feb.) 1000 w.

†10580. The Taxation of Ground Rents. J. Powell Williams (N C–Feb.) 7300 w.

*10635. The Liability of Employers for Accidents to Workmen. Editorial (E–Feb. 10.) 1500 w.

*10688. Strikes, Their Effects and Remedies. J. H. Peter (S–Feb.) 1300 w.

*10689. National Organization of Quarrymen. Sylvester Marshall (S–Feb.) 2000 w.

†10718. A New Era for the United States. George W. Medley (F–March.) 3000 w.

†10721. The Condition of Wage-Earning Women. Clare de Graffenreid (F–March.) 6800 w.

10723. Direct Trade and Agriculture. I. W. Avery (M R–Feb. 24.) 1300 w.

*10875. Where Do Wages Come From? (J G L–Feb. 21.) 2000 w.

*10983. The Forty-Eight Hour Week. Editorial (Eng L–Feb. 24.) 2000 w.

11089. The Development of Technical Societies. John Birkinbine (E N–March 9.) 1400 w.

Serials.

11056. The Social Quagmire and the Way Out of It. Alfred R. Wallace (A–Began March—1 part to date—45 cts).

LANDSCAPE ENGINEERING.

10917. Villa-Garden Landscapes. James MacPherson (Am G–Feb.) 1000 w.

10945. Grasses for Lawns. C. L. Allen (Am A–March.) 600 w.

MARINE ENGINEERING.

10517. To Encourage American Shipbuilding (B I S–Feb. 15.) 800 w.

10554. Direct Foreign Trade for the South. H. B. Crosby (M R–Feb. 17.) 1200 w.

10586. Steamship Manitou, Lake Michigan and Lake Superior Transportation Co. Ill. (M R C–Feb. 16.) 2200 w.

*10634. Thornycroft's Screw Turbine Propeller. Ill. (E–Feb. 10) 1000 w.

*10686. Decadence of American Shipping. Alexander H. Smith (S–Feb.) 1400 w.

*10731. The Abysmal Depths of the Sea. Ill. J. Carter Beard (Cos–March.) 2200 w.

*10735. The British Navy. Ill. S. Eardley-Wilmot (Cos–March.) 4800 w.

10771. Seaboard Accommodates Secretary Foster. Alexander R. Smith (Sea–Feb. 23.) 1500 w.

10772. The American Line. Ill. (Sea–Feb. 23.) 1800 w.

10864. The Monterey. Ill. (Sc A S–March 4.) 900 w.

10866. American Ocean Commerce. Editorial (Sc A–March 4.) 1000 w.

10869. Raising the Flag on the Steamship New York. Ill. (Sc A–March 4.) 1200 w.

10894. Our First Battle-Ship—The Indiana. Ill. (Sea–March 2.) 550 w.

10895. Successful Preliminary Trial of the Steamship Howard Cassard (Sea–March 2.) 1100 w.

10926. F. W. Wheeler's No. 100.—A Great Shipping Record. Ill. (M R C–March 2.) 1800 w.

*10970. Chicnecto Ship Railway.—History and Manner of the Transportation of Ships (R A E J–March.) 1800 w.

*10984. The Protection of English Commerce. Editorial (Eng L–Feb. 24.) 1200 w.

11020. The Bernstein Sculling Propeller. Ill. (Am S–March 2.) 800 w.

*11042. The Coaling of Ocean Steamers (C G–Feb. 24.) 1500 w.

11073. The German Dispatch Boat "Hohenzollern." Ill. (Sc A S–March 11.) 850 w.

11076. The Coming Naval Review. Editorial (Sc A–March 11.) 650 w.

11078. United States Steamship "Iowa." Ill. (Sc A–March 11.) 700 w.

11079. An Automatic Wave Subduer. Ill. (M N–March 1.) 650 w.

Serials.

10888. Marine Propulsion. Ill. I. McKim Chase (A M–Began March 2—1 part to date—15 cts).

10893. American Marine. William W. Bates (Sea–Began March 2—2 parts to date—15 cts. each).

MECHANICAL ENGINEERING.

*10567. The Durability of Wire Ropes. Ill. M. Jacob (C E–Feb.) 2700 w.

*10574. A Test of Viscosimeters. G. F. Wagner and K. B. Miller (S J E–Feb.) 1400 w.

10653. Conical vs. Cylindric Cam Boilers. S. W. Robinson (A M–Feb. 23.) 700 w.

10668. Proper Use of Terms. Carl Hering (E W–Feb. 25.) 1000 w.

10676. The Sellers 40-Ton Dock Crane. Ill. (Ir Age–Feb. 23.) 1000 w.

*10747. A Novel Cycle Boat —Zimer's Patent. Ill. (Inv–Feb. 18.) 900 w.

10770. The Serrell Improved Derrick. Ill. (A M & I W–Feb. 24.) 1200 w.

*10803. The Dredge-Steward Omnitelemeter. Ill. (E–Feb. 17.) 1200 w.

10834. Superintendence. B. F. Spalding (A S–Feb. 25.) 2000 w.

10887. Rotary Protractor for Circular and Band Saws. Ill. John M. Richardson (A M–March 2.) 2100 w.

10889. Cylindrical vs. Conical Cam Rollers. Oberlin Smith (A M–March 2.) 500 w.

10898. The Price Current Meter. Ill. (E N–March 2.) 900 w.

10902. Concerning Rivet Values. Ill. Friedrich Edler von Emperger (E N–March 2.) 1100 w.

11031. Danger in the Grind-Stone (M & B–Feb.) 600 w.

11075. The Casting of a Large Steam Cylinder. Ill. (Sc A–March 11.) 700 w.

11084. A Weldless Chain. Ill. (I T R–March 9.) 2100 w.

Serials.

7865. Notes on Rope Driving. Ill. M. E. (A M–Began Nov. 10—3 parts to date—15 cts. each).

8318. Principles, Possibilities, Curiosities, and Limitations of the Crank Motion. Leicester Allen (Eng–Began Nov. 26—Ended Feb. 18—6 parts—15 cts. each).

11039. Helico Centrifugal Ventilator. Ill. M. Rateau (C G–Began Feb. 24—1 part to date—30 cts).

11082. Belts—The Influence of Speed—Dimensions of Pulleys. Charles A. Hague (E A–Began March 11—1 part to date—15 cts).

METALLURGY.

*10569. Going Into Blast with a Coke Furnace. J. S. Kennedy (C E–Feb.) 4000 w.

*10625. The Durham Coke Trade (C G–Feb. 10.) 1000 w.

*10629. Soldering Aluminum (I–Feb. 10.) 600 w.

*10631. "Metallurgical Errors." J. E. Stead (I–Feb. 10.) 1900 w.

10640. The Bates Steel Process (A S–Feb. 18.) 700 w.

*10644. New South Wales Coke. Edward T. Pittman (A M S–Jan. 7.) 2500 w.

10679. Lamination In Metal (Ir Age–Feb. 23.) 900 w.

10712. The Production of the Precious Metals in 1892—Director of the Mint's Report (E M J–Feb. 25.) 1000 w.

10713. Use of Producer Gas for Drying and Roasting Ore at the Lixiviation Mill of the Holden Smelting and Milling Company, Aspen, Colo. Willard S. Morse (E M J–Feb. 25.) 550 w.

*10741. Some Remarks on Ore Imports from Spain in 1892. Walter J. May (I–Feb. 17.) 1000 w.

*10778. The Bates' Process—Letters from Vulcan and H. Augustus Guy (I & S–Feb. 18.) 900 w.

*10779. The Swedish Iron Industry (I & S–Feb. 18.) 1600 w.

*10788. Ferro-Metallic Compounds (C G–Feb. 17.) 1800 w.

10832. The Effect of Cold on Iron and Steel (R R–Feb. 25.) 500 w.

10880. The Greene-Wahl Process of Manufacturing Manganese and Alloys of Manganese Free from Carbon. F. Lynwood Garrison (Ir Age–March 2.) 2300 w.

10881. Titaniferous Ores in the Blast Furnace. Auguste J. Rossi (Ir Age–March 2.) 2100 w.

10883. A Visit to the Property and Plants of the Canada Iron Furnace Company (Ir Age–March 2.) 6000 w.

10890. Wanted a Wire Gage. Oberlin Smith (A M–March 2.) 1100 w.

10966. The Future of Platinum. Editorial (E M J–March 4.) 900 w.

*10975. Description of a 28-Inch Steel Mill, with Shears and Subsidiary Plant for the New British Iron Company, Limited, Birmingham. Jeremiah Head (I–Feb. 24.) 2200 w.

*10976. Chinese Metallurgical Undertakings. C. T. Gardner (I–Feb. 24.) 1400 w.

*10977. Ingot Molds. James Riley (I–Feb. 24.) 1200 w.

*10985. Coal and Coke Conveyors for Retort Houses and Coal Stoves. Ill. (Eng L–Feb. 24.) 1500 words.

10989. The Lead Ore Problem. Editorial (M I T–March 2.) 1100 w.

*11038. Low Grade Surface Hematite Ores and Their Treatment. Walter J. May (C G–Feb. 24.) 1500 w.

*11050. Palladium Plating (E R L–Feb. 24.) 900 w.

†11058. The Constitution of Nickeliferous Pyrrhotite. H. S. Emmens (J A C S–Dec.) 1500 w.

11083. Pig Iron Possibilities of Marquette. Richard A. Parker (I T R–March 9.) 2500 w.

Serials.

9459. The Manufacture of Coke. John Fulton (C E–Began Jan.—2 parts to date—30 cts. each).

10266. Castings. S. Bolland (F D–Began Dec.—2 parts to date—15 cts. each).

10275. The Analysis of Iron and Steel. J. Parry and J. J. Morgan (I L–Began Jan. 27—3 parts to date—30 cts. each).

10410. Development of the Coke Industry by Utilization of By-Products. B. Leistikow (A M & I W–Began Feb. 10—Ended Feb. 17—2 parts—15 cts. each).

10630. Engineer's Tests for Iron, Considered from an Ironmaster's Point of View. Thomas Morris (I–Began Feb. 10—Ended Feb. 17—2 parts—30 cts. each).

10892. Some Points in Silver-Milling by Amalgamation. C. H. Aaron (M S P–Began Feb. 25—2 parts to date—15 cts. each).

10971. The Resistance of Metal to Shear. Ill. H. V. Loss (R A E J–Began March—1 part to date—30 cts).

MILITARY ENGINEERING.

10514. The Fontainebleau Proving Grounds. Ill. (Sc A–Feb. 18.) 2000 w.

†10550. The Uselessness of Gibraltar. W. Laird Clowes (F R–Feb.) 4000 w.

*10585. The Navy of the United States. H. W. Raymond (Ch–March) 3000 w.

*10619. Cordite. Editorial (Eng L–Feb. 10) 1000 w.

10648. An Important Report upon Our New Navy, by Chairman Herbert (B I S–Feb. 22) 1000 w.

10678. The New Armor Specifications (Ir Age–Feb. 23.) 3000 w.

†10716. Hawaii and Our Future Sea Power. A. T. Mahan (F–March.) 4800 w.

†11059. The Army Organization Best Adapted to a Republican Form of Government, Which Will Ensure an Effective Force. Sydney E. Stuart (J M S I–March.) 18,900 w.

†11060. Telegraph in War. Jas. A. Swift (J M S I–March.) 3200 w.

11081. Gun and Shell Making. James Eastus Price (M N–March 1.) 1500 w.

Serials.

8241. Assault and Battery. Ill. A. Ewbank (I E–Began Oct. 22—12 parts to date—45 cts. each).

9347. Notes of Lectures on Artillery in Coast Defense. A. C. Hansard (J M S I–Began Jan —2 parts to date—45 cts. each).

10738. The Development of American Armor-Plate. Ill. F. Lynwood Garrison (M–Began Feb. 15—1 part to date—30 cts).

10957. Chinese Curios. Consul Bedloe (A A–Began March 4—1 part to date—15 cts).

MINING.

10516. Dakota Tin Mines. Wilder Grahamé (Min–Jan.) 1400 w.

10531. Spanish-American and Other Cuban Iron Mines. Ill. S. P. Ely (I T R–Feb. 16.) 3500 w.

10532. Wire Rope Tramway at the San Juan Mines. Ill. (E N–Feb. 16.) 800 w.

10556. Report of Inspector of Mines in West Virginia (M R–Feb. 17.) 600 w.

10560. Lead and Zinc Mines in the South. Ill. (T–Feb. 15.) 300 w.

10561. A Brief Golden Dream. Dan De Quille (E M J–Feb. 18.) 1000 w.

10562. Lead and Zinc Mining Industry of Missouri and Kansas in 1892. J. R. Holibough (E M J–Feb. 18.) 1100 w.

10563. The Mines of Sierra Mojada, Mexico. Eugene O. Fechet (E M J–Feb. 18.) 2500 w.

10564. Graduates of Mining Schools. Samuel B. Christy (E M J–Feb. 18.) 1900 w.

10565. The Persistence of Ores in Lodes in Depth.—The Empire Lode. H. M. Beadle (E M J–Feb. 18.) 300 w.

*10566. The Economic Geology of Tin. Ill. H. A. Wheeler (C E–Feb.) 1200 w.

*10571. The Best Types of Safety Lamps for Gas Testing Purposes. Ill. Alexander Dick (C E–Feb.) 800 w.

*10572. On Metal Mining. Ill. M. C. Ihlseng (C E–Feb.) 1000 w.

*10573. On Mining Machinery.—Hoisting Engines. F. W. Ewald (C E–Feb.) 1200 w.

10605. The Comstock Lode a Devourer of Forests. Ill. Dan De Quille (M I T–Feb. 16.) 1900 w.

*10624. Some Remarks on Wasted Coal. Walter J. May (C G–Feb. 10.) 1500 w.

*10642. The Mount Stewart Lead and Silver Mine (A M S–Jan. 7.) 1200 w.

*10643. Gold in Borneo.—A Field for Enterprise (A M S–Jan. 7.) 1500 w.

*10646. The White Cliffs Opal Field. (N. S. W.) John B. Jaquet (A M S–Jan. 21.) 2500 w.

10675. Where the Columbia River Gold Comes From. H. S. Back (M S P–Feb. 18.) 1000 w.

10714. The Gold Mining Industry of Nova Scotia in 1892 (E M J–Feb. 25.) 500 w.

10715. A Method of Transferring Surface Alignment Underground. Ill. L. Kuhn (E M J–Feb. 25.) 500 w.

†10720. The Cost of Silver and the Profits of Mining. J. D Hague (F–March.) 3700 w.

10725. Phosphate Developments About Fort Meade. Nodule (M R–Feb. 24.) 1000 w.

*10743. The Coal Trade Crisis in South Wales. Editorial (I L–Feb. 17.) 1300 w.

*10783. Mexico an Iron Producing Country. Editorial (I C T–Feb. 17.) 1200 w.

*10787. The Syndicating of the Coal Industry (C G–Feb. 17.) 2000 w.

*10789. The Carmaux-Albi Coalfield, France. Jules Laromiguière (C G–Feb. 17.) 2000 w.

*10797. On the Detection and Estimation of Small Proportions of Fire-Damp, Petroleum Vapor, and Other Inflammable Gas or Vapor in the Air. Ill. Frank Clowes (J S A–Feb. 17.) 10,000 w.

10882. The Biwabik Mine. U. V. Winchell and John T. Jones (Ir Age–March 2.) 400 w.

10891. Mineral Wealth of Eastern Oregon. D. E. Cummins (M S P–Feb. 25.) 1250 w.

10907. Copper Mining in the South. Ill. James G. Parks (T-March 1.) 2000 w.

10908. Iron Deposits in Texas. W. J. Singletary (T-March 1.) 750 w.

10924. Tin in the Malay Peninsula.—Report of Consul Wildman (A M & I W-March 3.) 2100 w.

10967. Geological Occurrence of the Broken Hill Ore Deposits. Ill. E. F. Pittman (E M J-March 4.) 800 w.

10968. The Relation Between Ore Deposits and Their Inclosing Walls. Harold W. Fairbanks (E M J-March 4.) 1600 w.

11012. The Coal and Iron Resources of Texas. W. S. A. (M R-March 3.) 1200 w.

*11040. Mining Labor in the United States (C G-Feb. 24.) 1500 w.

*11041. Spontaneous Combustion in Coal Mines. Arnold Lupton (C G-Feb. 24.) 2500 w.

11097. An Abnormal Borax Deposit. Ill. (M S P-March 4.) 400 w.

Serials.

10232. The Present Status of Natural Gas in Ohio. Edward Orton (A M & I W-Began Feb. 3—Ended Feb. 17—3 parts—15 cts. each).

10584. Scientific Phases of Mining. Albert Williams, Jr. (Ch-Began March—1 part to date—30 cts).

10623. General Theory of Turbo-Engines, with Special Reference to Mine Ventilators. M. Rateau (C G-Began Feb. 10—2 parts to date—30 cts. each).

10645. Croydon (U. Q.) (A M S-Began Jan. 14—2 parts to date—30 cts. each).

10724. The Phosphate Mines of Canada. H. B. Small (M R-Began Feb. 24—2 parts to date—15 cts. each.

10978. The Lührig Process of Washing and Treating Coal. James I'Anson (I-Began Feb. 24—1 part to date—30 cts.

RAILROADING.

*10505. Would the Pan-American Road Pay? Ill. Charles P. Yeatman (E Mag-April.) 3000 w.

10511. English Locomotives and Railway Management. W. H. Booth (A M-Feb. 16.) 1400 w.

10518. Railroads Toward the North Pole (B I S-Feb. 15.) 700 w.

10527. Use of Streets for Railroad Purposes.—Rights of Abutting Property Owners. LL. B. (S R N-Feb. 18.) 1300 w.

10536. The American Type of Freight Cars for European Railways (E N-Feb. 16.) 500 w.

10540. An English View of American Railways and Locomotives. Editorial and Letter (E N-Feb. 16.) 5000 w.

†10549. The New Railway Rates. J. Stephen Jeans (F R-Feb.) 6500 w.

10555. An Important Railroad Project. (M R-Feb. 17.) 550 w.

10575. Trestles on the Norfolk and Western. Ill. Emile Low (R G-Feb. 17.) 550 w.

10576. The New Orleans Bridge (R G-Feb. 17.) 600 w.

10577. The Western Section of the Trans-Siberian Railroad. Michel Nicolaevich Ghercevanof (R G-Feb. 17.) 2300 w.

*10587. The Rezende Viaduct of Old Rails. Ill. (A J R A-Feb.) 200 w.

10595. Should Sleeping Car Rates Be Reduced. Editorial (R A-Feb. 17.) 900 w.

10596. Railway Companies and their Employés. O. D. Ashley (R A-Feb. 17.) 3800 w.

10597. New Sheep Pens.—C. B. & Q. Railroad. Ill. (R A-Feb. 17.) 1000 w.

*10598. The Los Angeles Consolidated Electric Railway. Ill. (S R R-Feb.) 2000 w.

*10599. The Broadway Cable.—The Most Difficult Enterprise Undertaken by a Street Railway. Ill. (S R R-Feb.) 3500 w.

*10601. A Chinese Cable Line. Ill. (S R R-Feb.) 700 w.

*10602. An Argument in Favor of Ground Plates as Against a Continuous Copper Return. J. F. E. (S R R-Feb.) 2000 w.

10603. Street Railways and the West (S R G-Feb. 20.) 1400 w.

10604. The Green Electric Railway Patents. Ill. (S R G-Feb. 20.) 1500 w.

10606. Safety-Couplers. W. M. Mitchell (R R-Feb. 18.) 1800 w.

10607. Care of Foundation Brakes. Jas. Howard (R R-Feb. 18.) 1850 w.

10609. The Storehouse System of the Chicago, Burlington and Quincy Railroad (R R-Feb. 18.) 1600 w.

10610. Interlocking and Block Signal System.—C. & N. W. Ry. (R R-Feb. 18.) 1500 w.

10611. Co-operation of Railway Managers and Railway Commissioners. Editorial (R R-Feb. 18.) 800 w.

10612. Safety Appliance Legislation, with Bills (R R-Feb. 18.) 2500 w.

*10613. The Lighting of Railway Trains. Ill. Harry Pollitt (P Eng-Feb. 10) 2800 w.

*10620. English Locomotives in New South Wales. Ill. (Eng L-Feb. 10.) 800 w.

10652. Railways of Great Altitude in the Andes (Sc A S-Feb. 25.) 2600 w.

10663. Long Electric Railroads in Ohio (E E N Y-Feb. 22.) 1500 w.

10690. Special Train for the Emperor of Austria. Ill. (E N-Feb. 23.) 1200 w.

10693. Eight Years' Travel over Brooklyn Bridge (E N-Feb. 23.) 400 w.

10698. The Competitive Tests of the Westinghouse and New York Air Brakes on the N. Y. Central R. R. (E N-Feb. 23.) 6800 w.

10703. The West Albany Brake Trials, with Editorial (R G-Feb. 24.) 9000 w.

10704. The National Repeating Torpedo Signal. Ill. J. W. Lattig (R G-Feb. 24.) 2300 w.

10706. The Reading in the Hands of Receivers, with Editorial (R G–Feb. 24.) 2000 w.

10708. Blast Nozzles. Editorial (R G–Feb. 24.) 1300 w.

*10727. The Jaffa and Jerusalem Railway. Ill. Selah Merrill (Sc M–March.) 5700 w.

*10733. The Great Trans-Siberian Railway. Ill. Valerian Gribayédoff (Cos–March.) 4500 w.

10737. The Calumet Electric Railway. Ill. (S R G–Feb. 27.) 1000 w.

*10746. Electrical Block Interlocking Systems. R. Woods (I L–Feb. 17.) 1700 w.

10765. Rapid Transit in Boston.—Address of Henry M. Whitney (M G–Feb. 25.) 10,000 w.

10766. Rapid Transit. Editorial (M G–Feb. 25.) 600 w.

*10767. The Electric Railway to the Saleve near Geneva. Ill. (E L–Feb. 17.) 900 w.

*10782. The Shortlands and Nunhead Railways. Ill. A. G. Drury (Eng L–Feb. 17.) 4000 w.

10798. Railway Labor Organizations. Editorial and List (R A–Feb. 24.) 1600 w.

10799. Shortages in Railroad Accounts. E. P. Higgins (R A–Feb. 24.) 2800 w.

*10804. Heating Railway Carriages. Ill. (E–Feb. 17.) 1800 w.

10831. Railway Safety Appliances. H. S. Haines (R R–Feb. 25.) 2600 w.

10833. Heating Railway Cars in France (R R–Feb. 25.) 1000 w.

†10848. Denver and Its Street Railways. Ill. (S R J–March.) 1400 w.

10868. A Monster Locomotive. Ill. (Sc A–March 4.) 500 w.

10873. An Electric Headlight. Ill. (E N Y–March 1.) 2500 w.

10899. The Abt Rack Railway in Syria (E N–March 2.) 700 w.

10901. Shocks in Air Brake Tests (E N–March 2.) 1000 w.

10903. Statistics Showing the Track Laying of 1892, and the Prospective Railway Construction of 1893, with Map (E N–March 2.) 7300 w.

*10909. Cutting Eccentric Keyways Before Wheels Are Placed Under Engines. Ill. Fred S. Hill (L E–March.) 1500 w.

*10911. Improvements at the Pittsburg Locomotive Works. Ill. J. A. H. (L E–March.) 1600 w.

*10912. Compound and Simple Engines. Hugh Sharp (L E–March.) 1300 w.

*10913. Setting Up Wedges, Keying Side-Rod Brasses, and Tramming Engines. G. K. W. (L E–March.) 1200 w.

*10914 The Brazilian Central Railway. Lewis Gleason (L E–March.) 1800 w.

*10915. The Greater Santa Fé Trail." A. S. (L E–March.) 2000 w.

10935. The Possibilities of Fraud in Present Systems of Freight Accounting. A. D. Oyer (R A–March 3.) 1200 w.

10936. Two Cents per Mile in Missouri. W. C. Brown (R A–March 3.) 2500 w.

10962. Wheel Gage Limits. Editorial. Ill. (R M M–March.) 1500 w.

10963. The Use of Compressed Air in Railroad Shops. Ill. F. M. Twombley (R M M–March.) 1000 w.

10964. Tests of Locomotives in Heavy Express Service. Ill. William Forsyth (R M M–March.) 2000 w.

10965. Oil Furnace for Blacksmith Shops.—Pittsburgh, Cincinnati, Chicago and St. Louis R. R. Ill. (R M M–March.) 800 w.

*10974. Railway-Carriage Warming in England. Ill. (I–Feb. 24.) 2000 w.

*10982. Electrical Railways.—Abstract of paper by Edward Hopkinson (I C T–Feb. 24.) 1100 w.

*11003. The Railways and the Public. Editorial (I L–Feb. 24.) 3500 w.

11005. A Criminal Structure. Ill. Quintin McNab (R R–March 4.) 1200 w.

11006. Signaling Plant on the New York, New Haven and Hartford Railroad. Ill. (R R–March 4.) 700 w.

11008. The Law Governing the Application of Railway Safety Appliances (R R–March 4.) 800 w.

11009. Synopsis of the New German Railway Regulations (R R–March 4.) 1200 w.

*11017. Electric Lights for Railway Signals. Ill. (E I–March.) 1300 w.

11021. Northern Pacific Affairs.—Letter from "A Stockholder" (R G–March 3.) 1000 w.

11022. A Defect in Organization—Letter from L. E. H. (R G–March 3.) 1200 w.

11023. The Dangers of Oil Transportation. Senex (R G–March 3.) 1000 w.

11026. The Reading Receivership. Editorial (R G–March 3.) 1300 w.

11027. "A Defect in Railroad Organization." Editorial (R G–March 3.) 1400 w

11029 The Adventures of a Way-Bill. Thomas Coam (R G–March 3.) 1700 w.

*11043. Progress of Cable Traction. Editorial (Inv–Feb. 25.) 3000 w.

11047. The "Vulcanizing" Process for Preserving and Strengthening Poles, Cross-Arms, Ties, etc. H. C. Myers (E A–March 4.) 700 w.

*11048. Facts Concerning the Siemens Electric Railway of the Year 1879. A. M. Tanner (E R L–Feb. 24.) 1000 w.

*11054. Tube-Frame Goods Wagon. Ill. M. R. Jefferds (R W–Feb.) 2800 w.

*11055. Railway Freight Rates in England and America. M. R. Jefferds (R W–Feb.) 1400 w.

11092. The Monte-Generoso Rack Railway. (E N–March 9.) 450 w.

11093. Uniformity in Freight Car Draft Gear (E N–March 9.) 2500 w.

Serials.

5219. The $350,000 Cable Road and the $46,000 Electric Road. Cable Railways (S R J–Began July—5 parts to date—45 cts. each).

9739. New Railways in Spain. Ill. (I L-Began Jan. 6—2 parts to date—30 cts. each).

10111. The Liverpool Overhead Railway. Ill. (E E L-Began Jan. 20—Ended Feb. 10—3 parts—30 cts. each).

10378. The Evolution of the Railroad Turntable. Ill. C. A. Greenleaf (R G-Began Feb. 10—2 parts to date—15 cts. each).

10446. Permanent Way for Viaducts. Ill. Herbert Tatham Procter (R R-Began Feb. 11—Ended March 4—2 parts—15 cts. each).

*10502. English and American Railways. Wm. M. Acworth (E Mag-Began April—1 part. to date—30 cts).

10709. Strikes or No Strikes (R G-Began Feb. 24—2 parts to date—15 cts. each).

11007. Transcontinental Railways. Edward P. Vining (R R-Began March 4—1 part to date—15 cts).

SANITARY ENGINEERING.

10694. The Effect of Frost on the Sewage Filtration Beds at South Framingham, Mass. (E N-Feb. 23.) 650 w.

10696. The Use of Sewage for Irrigation in the West. Editorial (E N-Feb. 23.) 1400 w.

10728. Plumbing for a City House. Ill. (Met W-Feb. 25.) 2300 w.

10755. Heating and Ventilation of a Baltimore Church. Ill. (E R-Feb. 25.) 1800 w.

†10905. The Need of Sanitary Supervision of Schools. Jerome Walker (San-March) 6000 w.

*10921. Notes on Sewage and Sewers. Louis H. Gibson (P-March) 1800 w.

10944. Importance of Pure Water. Henry Stewart (Am A-March.) 1300 w.

10973. The Dangers of City Refuse (Eng-March 4.) 1300 w.

Serials

5358. Sewage Purification in America (E N-Began July 14—23 parts to date—15 cts. each).

8127. Ventilation and Heating. John S. Billings (E R-Began Nov. 19—4 parts to date—15 cts. each).

10425. A Healthy Home. Francis Vacher (S R-Began Feb. 1—2 parts to date—30 cts. each).

10557. Sewage Treatment and Sludge Disposal. W. Santo Crimp (E R-Began Feb. 18—Ended March 4—3 parts—15 cts. each).

10641. Purifying Water for Household Supply (S P-Began Feb. 15—1 part to date—15 cts).

10942. The New York Plumbing Regulations. Arthur Howell Napier (E R-Began March 4—1 part to date—15 cts).

STEAM ENGINEERING.

10521. Marine Engines on Land (S V-Feb. 15.) 1000 w.

10546. Spring Safety Valves (S E-Feb. 11.) 1000 w.

10547. Inspection and License Law. John A. Davis (S E-Feb. 11.) 900 w.

*10570. Cylindrical Boilers.—A Successful Plan for Increasing Their Efficiency. Ill. James Pollock (C E-Feb.) 1600 w.

*10589. Grates (A J R A-Feb.) 1500 w.

10594. Setting Engine Valves. Ill. (B J C-Feb. 18.) 2300 w.

*10621. The Mystery of Steam. Letters of Robert Mansell and William Donaldson (Eng L-Feb. 10.) 2000 w.

10705. Some Thoughts on Boiler Inspection. John Hickey (R G-Feb. 24.) 1400 w

10762. The Steam Engine Indicator, Applied to an Unevenly Balanced Engine (B J C-Feb. 25.) 650 w.

10763. Boiler Feed Pipes (B J C-Feb. 25.) 1000 w.

10764. Steam Power's Discoverer.—The Painful Story of Samuel Caus (B J C-Feb. 25.) 600 w.

*10790. Winding Engines (C G-Feb. 17.) 1800 w.

*10826. Hot Water Storage. W. H. Booth (E R L-Feb. 17.) 1000 w.

10879. Deterioration of Condenser Tubes in the United States Steamship "Baltimore" (Ir Age-March 2) 1800 w.

10886. Waste Steam Injectors. W. H. Booth (A M-March 2.) 1300 w.

*10910. Heat and Combustion. Angus Sinclair (L E-March.) 2800 w.

*10916. Manipulating Boiler Plates (L E-March.) 900 w.

10940. Flue Temperatures as Affected by Firing. Ill. David M. Greene (E R-March 4.) 450 w.

10950. The Strength of Shafting (B J C-March 4.) 1200 w.

10951. Steel Boiler Tubes.—Will They Supersede Iron? (B J C-March 4.) 700 w.

10952. A Corliss Valve Trouble. Ill. (B J C-March 4.) 500 w.

10972. Sequence of Cylinders and Cranks in Triple Expansion Marine Engines. W. J. Winterburn (Eng-March 4.) 1500 w.

11071. Injector Notes—Ejector Condensers. W. H. Booth (A M-March 9.) 1500 w.

Serials.

7456. The Locomotive Boiler. Ill. Gustav Richard (A J R A-Began Oct.—4 parts to date—30 cts. each).

10664. Apparatus for Determining the Amount of Water in Steam. W. R. Cummins (I L-Began Feb. 10—Ended Feb. 17—2 parts—30 cts. each).

10681. Compound Expansion Engines (Ir Age-Began Feb. 23—1 part to date—15 cts).

10726. The Development of the Steam Engine (M R C-Began Feb. 23—2 parts to date—15 cts. each).

10946. Hints. W. H. Wakeman (M G-Began March 4—1 part to date—15 cts).

11001. Thermodynamic and Adiabatic Diagrams of Water and Steam. Ill. R. H. Smith (I L-Began Feb. 24—1 part to date—30 cts).

11085. The Causes of Corrosion in Steam Boilers. William H. Edgar (S E–Began March 4—1 part to date—15 cts).

TELEPHONY AND TELEGRAPHY.

10512. The Crowning Achievements of the Telephone (Sc A–Feb. 18.) 1000 w.

10519. The Death of Dr. Norvin Green. Ill. (E W–Feb. 18.) 800 w.

*10529. One Use for the Telephone. Ill. F. S. Marsh (E E L–Feb. 3) 900 w.

10649. The Berliner Microphone Patent. Editorial (Sc A–Feb. 25.) 1400 w.

10680. The Submarine Cable Systems of the World (Ir Age–Feb. 23) 1000 w.

10702. Berliner Telephone Litigation. Editorial (W E–Feb. 25.) 2800 w.

*10768. The Latest Telegraph Statistics (E L–Feb. 17.) 400 w.

10819. The Telephone.—Its Legal History and Commercial Condition Presented by a Master Hand. Grosvenor P. Lowry (E R N Y–Feb. 25.) 3500 w.

10822. Telephone Improvement (E R N Y–Feb. 25.) 950 w.

*10828. The Chin Column Telegraph Expedition. F. E. Dempster (E R L–Feb. 17.) 4200 w.

10839. The Famous Bell Patent. Ill. (E R N Y–March 4.) 3000 w.

*11051. An Improved Telephone Switchboard System. Ill. (E R L–Feb. 24.) 1100 w.

Serials.

6515. Notes on Submarine Cable Work. Ill. H. D. Wilkinson (El–Began Sept. 2—Ended Feb. 17—10 parts—30 cts. each).

10285. Inaugural Address of W. H. Preece (E E L–Began Jan. 27—Ended Feb. 3—2 parts—30 cts. each).

10470. The Theory of Submarine Cable Laying. G. W. Littlehales (E E N Y–Began Feb. 15—Ended Feb. 22—2 parts—15 cts. each).

10669. The Telephone Situation (E W–Began Feb. 25—2 parts—15 cts. each).

MISCELLANEOUS.

*10501. A Decade of Marvelous Progress. R. H. Edmonds (E Mag–April.) 3000 w.

*10506. Refrigeration from Central Stations. John E. Starr (E Mag–April.) 3000 w.

*10507. Conditions of Forestry as a Business. W. J. Beal (E Mag–April.) 3000 w.

*10508. An Early Engineering Magazine. Hyland C. Kirk (E Mag–April.) 3000 w.

*10509. The Past and Future of Engineering. Gordon B. Kimbrough (E Mag–April.) 3000 w.

10515. Motors for Aerial Machines. Abstract from a Lecture by O. Chanute (Sc A S–Feb. 18.) 2500 w.

10522. Will We Navigate the Air? Ill. Hiram Maxim (S V–Feb. 15.) 3000 w.

†10581. Commercial Unity with the Colonies. Augustus Loftus (N C–Feb.) 3000 w.

*10617. Municipal Contracts. Alfred H. Gibbings (E R L–Feb. 10.) 1600 w.

*10626. The Wiborgh Luft (Air) Pyrometer. Emanuel Trotz (C G–Feb. 10.) 1500 w.

10655. Attacks on City Parks (G & F–Feb. 22.) 1200 w.

*10685. The Onyx Deposits of Cave Creek, Arizona. George P. Merrill (S–Feb.) 700 w.

10699. The Art of To-day. C. F. A. Voysey (A & B–Feb. 25.) 2200 w.

†10719. The Science of Municipal Corruption (F–March.) 4000 w.

†10722. An Appeal to Retire Government Paper Money. M. Brühl (F–March.) 2200 w.

*10732. In Our Cotton Belt. Ill. H. S. Fleming (Cos–March.) 4500 w.

*10734. An Italian Campo Santo. Ill. Murat Halstead (Cos–March.) 3500 w..

10754. The Status of the Engineering Profession. H. F. J. Porter (E R–Feb. 25.) 900 w.

10760. Brief Historical Review of the Lakes and Gulf Waterways. J. R. Leighty (R T–Feb.) 1200 w.

10777. The Downfall of the Hawaiian Monarchy. William T. Brigham (B C–Feb. 25.) 1800 w.

*10796. On Pottery Glazes: Their Classification and Decorative Value in Ceramic Design. Ill. Wilton P. Rix (J S A–Feb. 17.) 1300 w.

*10805. The Commercial Aspect of an Engineer's Training. Editorial (E–Feb. 17.) 1200 w.

*10809. The Future of Sculpture (A L–Feb. 17.) 2000 w.

†10850. American Farming A Hundred Years Hence. J. M. Rusk (N A R–March.) 2800 w.

†10851. The Sandwich Islands.—I. The Advantages of Annexation. Lorrin A. Thurston. II. Is It Constitutional? George Ticknor Curtis (N A R–March.) 8200 w.

†10852. Modern Insurance and Its Possibilities. R. A. McCurdy, J. L. Greene, Sheppard Homans, and Clarence H. Kelsey (N A R–March.) 7200 w.

†10854. England in the Orient. Arminius Vambery (N A R–March.) 2000 w.

†10855. National Banking and the Clearing House. A. B. Hepburn (N A R–March.) 4200 w.

*10856. America in Hawaii. Ill. Sereno Bishop (R of R–March.) 4800 w.

*10857. England in Egypt. Ill. (R of R–March.) 6300 w.

10867. The Manufacture of Dynamite. Ill. Maxime Vuillaume (Sc A–March 4.) 2000 w.

10876. The Principles of Economic Legislation. Edward A. Ross (P A–March 1.) 1600 w.

*10896. The Recent Survey in St. Louis.—Its Methods and Results. Ill. B. H. Colby (J A E S–Jan.) 14,000 w.

10904. Asphalt Pavements.—How They Should Be Cleaned (E N–March 2.) 2600 w.

10919. Some Causes of Failure of Heating

Apparatus. Franklin Van Winkle (A Ar–March 4.) 1700 w.

10925. The Fuel Question. Editorial (A M & I W–March 3.) 1000 w.

10937. "The Status of the Engineering Profession." Peter Milne (F W–March 4.) 900 w.

10941. Test of a Hot Water Heating Plant. Ill. (E R–March 4.) 3000 w.

10947. Value of Spruce Forests. Editorial (M G–March 4.) 1100 w.

10948. The Distinction Between the Patent Systems of the United States and Those of Other Countries. A. Steuart (I Age–March.) 3800 w.

10949. On the Wing.—Imitation of Birds and Insect Flight. Ill. Si. O. Bud (I Age–March.) 500 w.

10953. The Fuel Oil Plant at the Columbian Exposition. Ill. (P S–March.) 2200 w.

11011. Engineering Progress. Alfred E. Hunt (R R–March 4.) 1600 w.

11014 Perpetual Motion Infatuation. Editorial (M R–March 3.) 900 w.

11030. Carelessness in Pipe Fitting (Met W–March 4.) 3500 w.

11032. An Aboriginal Soapstone Quarry (M & B–Feb.) 1000 w.

11095. The Use of Burlap for Levee Protection During High Water. E. J. Chamberlain (E N–March 9.) 800 w.

Serials

9401. World's Columbian Exposition (E N–Began Jan. 5—3 parts to date—15 cts. each).

9519. Municipal Equipment and Engineering of Paris Jas. W. Howard (P–Began Jan.—Ended March—3 parts—30 cts. each).

9745. American Industries and British Commerce (E–Began Jan. 6–6 parts to date—30 cts. each).

9851. The Glass Industry. Ill. C. Hanford Henderson (P S M–Began Feb.—Ended March—2 parts—45 cts. each).

10490. The Diffusion of Light. W. E. Sumpner (El–Began Feb. 3—Ended Feb. 17—3 parts—30 cts. each).

10535. Notes from the Engineering Schools (E N–Began Feb. 16—3 parts to date—15 cts. each).

NEW BOOKS OF THE MONTH.

(For the convenience of readers any American books will be supplied at publishers' prices by **The Engineering Magazine Co.** Foreign books, 25 per cent. extra.)

Abbe, Cleveland.=The Mechanics of the Earth's Atmosphere: A collection of translations. Washington, D. C.: Smithsonian Institution. [Paper, 327 p.]

Bankson, Lloyd.=Slide-Valve Diagrams; A French Method of Obtaining Slide-Valve Diagrams. New York: D. Van Nostrand Co. [16mo, boards, 50c.]

Baye, J. de.=The Industrial Arts of the Anglo-Saxons: From the French, by T. B. Harbottle. New York: Macmillan. [Folio, cloth, 181 p., $7.]

Bedell, Frederick, and Crehore, Albert C.=Alternating Currents: An Analytical and Graphical Treatment for Students and Engineers. New York: W. J. Johnston Co. [8vo, 325 p., $2.50.]

Bonney, G. E.=Electrical Experiments: A Manual of Instructive Amusement. New York: Macmillan. [12mo, cloth, 265 p., 75c.]

Bottone S. R.=How to Manage the Dynamo: A handbook for ship engineers, electric light engineers, and electro-platers. New York: Macmillan. [12mo, cloth, 65 p., 60c.]

Gilbert, W.=On the Lodestone and Magnetic Bodies, and on the Great Magnet of the Earth: a translation by P. Fleury Motlelay. New York: Wiley. [8vo, cloth, 384 p., $4.]

Gray, Andrew.=The Theory and Practice of Absolute Measurements in Electricity and Magnetism. New York: Macmillan. [12mo, cloth, $6.25.]

Hett, C. L.=The Turbine Manual and Millwright Handbook. New York: Spon. [8vo, paper, 80c.]

Hiles, Theron L.=The Ice Crop: how to harvest, store, ship, and use ice. New York: Orange Judd Co. [12mo, cloth. 125 p., $1.]

Infantry Drill Regulations, U. S. Army:—With Interpretations of 250 Pars.: by the Recorder of the Tactical Board. New York: Army and Navy Journal, Appleton. [32mo, paper, 398 p., 30c.]

Jeffrey Manufacturing Co., Columbus. O.=Elevating and Conveying Machinery. A new catalogue for 1893, elaborately illustrated and so replete with tabulated statistics and practical information that it may rightly be called a textbook covering the whole broad field. [8vo, paper, 260 p., free on application to the firm.]

Kundsen, Augustus.=Triangular Surveys from Single Stations. San Francisco: Brunt & Co. [32mo, paper, 32 p., $1.]

La Rue, B. F.=A Graphical Method for Swing-Bridges. New York: D. Van Nostrand Co. [16mo, boards, 50 cts.]

Nasmith, Jos.=Students' Cotton Spinning. New York: D. Van Nostrand Co. [12mo, cloth, $3.]

Reece, Benjamin.="Railway Specialties" Vol. I. No. 1. A humorous periodical, modeled after "Life"; elaborately and takingly illustrated, and designed for the entertainment of railroad men, while at the same time making known the virtues of certain railway appliances. An original and striking publication which every railroad man should possess. [Sent free on application. The Q. & C. Co., Chicago-NewYork.]

Water Tower, Pumping and Power Station Designs: The Engineering Record's 34 Prize Designs. [4to, cloth, $2.]

THE TECHNICAL INDEX.

A CATALOGUE OF LEADING ARTICLES PUBLISHED CURRENTLY IN THE TECHNICAL JOURNALS OF THE UNITED STATES AND GREAT BRITAIN.

THIS publication has been aptly described as "the greatest step that has been taken in recent years towards systematizing work" for the engineer, the architect, the electrician, the railway manager, and the business man. The list of publications regularly indexed will show that it covers a world-wide range of the best technical literature, and all the articles are so conveniently classified under general headings that within a few minutes an active man can learn of everything that has been published during the month in relation to his special lines of investigation. In short, it is to the practical man just what Poole's celebrated index to periodicals has long been to the literary worker, but with this essential difference,—namely, that in addition to indicating *just where* leading articles have been published, *we undertake to supply copies of the articles themselves.* The unparalleled convenience and economy of this double service can readily be appreciated.

IN ordering articles from us, care should be taken to give the *number*, not the title alone. The price of a single article is 15 cents, excepting those indicated by an asterisk (*), 30 cents, and by a dagger (†), 45 cents—according to the price of the publication quoted. All orders *must* be accompanied by cash or stamps.

To avoid frequent remittances and to cheapen the cost of articles to those who order largely, we sell coupons at the rate of 15 cents each, or 15 for $2, 40 for $5, and 100 for $12.50. Each coupon is receivable in exchange for one 15-cent article; those marked * require two coupons, and those marked † require three coupons. This system is strongly commended. The coupons need only a trial to demonstrate their great convenience and economy of time and money.

* [In the body of the index only the initials of the journals quoted are given, and these can be readily identified by the following list of periodicals. Other abbreviations are: Ill=Illustrated. W=words.]

THE AMERICAN PRESS.

A ....Arena. *m.* $5 per year. Boston.
AA......American Architect. *w.* $6. Boston.
An A A..Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
A An.... American Analyst. *f.* $1 per year. N. Y.
A Ar.....American Artisan. *w.* $2. Chicago.
A & B....Architecture and Building. *w.* $6. N. Y.
A B M...Architect, Builder, and Manufacturer. *m.* $1.50. Kansas City, Mo.
A CJ....Am. Chemical Journal. *b-m.* $4. Baltimore.
A D... ..American Druggist. *m.* $1.50. New York.
A E ... .Architectural Era. *m.* $3. N. Y.
A E R J. American Engineer and Railroad Journal. *m.* $3. New York.
A G......Am. Geologist. *m.* $3.50. Minneapolis.
A G L J..Am. Gas Light Journal. *w.* $3. New York.
A H......Annals of Hygiene. *m.* $2 per year. Phila.
A J Phar. Am. Journal of Pharmacy. *m.* $3. Phila.
A J R A..Journal of Railway Appliances. *m.* $2 per year. New York.
A M .....American Machinist. *w.* $3. New York.
A M & I W. American Manufacturer and Iron World. *w.* $4 per year. Pittsburg.
Am A....American Agriculturist. *m.* $1.50. N.Y.
Am G ...American Gardening. *m.* $1. N. Y.
A M M...American Mechanics. *m.* $1. Minneapolis.
Am M....American Miller. *m.* $2. Chicago.
Am S....American Shipbuilder. *w.* $2. N. Y.
A & N J..Army and Navy Journal. *w.* $6. New York.
A & N R..Army and Navy Register. *w.* $3 per year. Washington.
A R......Architectural Record. *q.* $1. New York.
A Rev....Architectural Review. *s-q.* $5. Boston.
A S .....Age of Steel. *w.* $3. St. Louis.
At M.....Atlantic Monthly. *m.* $4 per year. Boston.
B B......Brick Builder. *m.* $2.50. Boston.
B C......Boston Commonwealth. *w.* $2.50.
B & D ...The Builder and Decorator. *m.* $2. Minneapolis.
B G S .. Bulletin of the American Geographical Society. *q* $5. N. Y.
B I S ....Bulletin of American Iron and Steel Association. *w.* $4. Phila.
B J C....Boston Journal of Commerce. *w.* $3 per year. Boston.
B P .....Bulletin of Pharmacy. *m.* $1. Detroit.
B & W...Builder and Woodworker. *m.* $1. N. Y.
C........Compass. *m.* $1 per year. New York.
C A......Calif. Architect. *m.* $3. San Francisco.
Can A . Canadian Architect. *m.* $2. Toronto.
C & B... Carpentry and Building. m. $1. New York.
C B T....Builder and Trader. *w.* $2. Chicago.
C E .....Colliery Engineer. *m.* $2. Scranton, Pa.
C E N... Canadian Electrical News. m. $1 per year. Toronto.
Ch ......Chautauquan. *m.* $2. Meadville, Pa.
C M......Century Magazine. *m.* $4 per year. N. Y.
Cos......Cosmopolitan. *m.* $3 per year. New York.
D E......Domestic Engineering. *m.* $1. Chicago.
D J... ..Drainage Journal. *m.* $1. Indianapolis.
D Jour. .Druggists' Journal. *m.* $1. Chicago.
E A .....Electrical Age. *w.* $3 per year. New York.
E E N Y..Electrical Engineer. *w.* $3 per year. N. Y.
E I..... .Electrical Industries. *m.* $3. Chicago.
E M......Engineering Mechanics. *m.* $2. Phila.
E Mag ...Engineering Magazine. m. $3. New York.
E M J....Engineering and Mining Journal. *w.* $4 per year. New York.
E N......Engineering News. *w.* $5 per year. N. Y.
Eng .....Engineer. *s-m.* $2 per year. New York.
E N Y....Electricity. *w.* $2.50. N. Y.
E P D....Electrical Progress and Development. $2. Boston.
E R..... Engineering Record. *w.* $5. N. Y.
E & R ...Electricity and Railroading. *m.* $1 per year. Boston.
E R N Y. Electrical Review. *w.* $3 per year. N. Y.
E W......Electrical World. *w.* $3 per year. N. Y.
F ...... Forum. *m.* $5 per year. New York.
F D......The Foundry. *m.* $1. Detroit.
F M......Farm Machinery. *m.* $1. St. Louis.
F W .....Fire and Water. *w.* $3 per year. N. Y.
G & F....Garden and Forest. *w* $1 per year. N. Y.
G G M...Goldthwaite's Geographical Magazine. *m.* $2 per year. N. Y.
G R......Good Roads. *m.* $2 per year. N. Y.
I A. ....Inland Architect. m. $5 per year. Chicago.
I Age....Inventive Age. *s-m.* $1. Washington.
Ir Age..Iron Age. *w.* $4.50. N. Y.
I R W...India Rubber World. *m.* $3 per year. N. Y.
I S F....Industry. *m.* $2 per year. San Francisco.
I T R....Iron Trade Review. *w.* $3. Cleveland.
J A .....Journal of Architecture. *m.* $2. Phila.
J A C S..Journal of the American Chemical Society. *m.* $5 per year. N. Y.
J A E S. Journal of the Association of Engineering Societies. *m.* $3 per year. Chicago.

J F I.....Journal of the Franklin Institute. *m.* $5 per year. Philadelphia.
J M S I..Journal of the Military Service Institution. *b-m.* $4 per year. Governor's Island, N. Y. H.
J N E W.Journal of the N. E. Waterworks Association. *q.* $2. New London, Conn.
J P E.....Journal of Political Economy. *q.* $3. Chicago.
J U S A..Journal of the United States Artillery. *q.* $2.50. Fort Monroe, Va.
L E......Locomotive Engineering. *m.* $2. N. Y.
L F M...Locomotive Firemen's Magazine. *m.* $1. Terre Haute, Ind.
L M......Leather Manufacturer. *m.* $3. N. Y.
L Mag...Lippincott's Magazine. *m.* $3. Phila.
L P .....Louisiana Planter. *w.* $3. New Orleans.
M & B...Manufacturer and Builder. *m.* $1.50. N. Y.
M & El...Mechanic and Electrician. *w.* $2 per year. St. Louis.
Met W...Metal Worker. *w.* $2 per year. N. Y.
M G......Manufacturer's Gazette. *w.* $2.50. Boston.
Min......Minerals. *m.* $1 per year. N. Y.
M I T....Mining Industry and Tradesman. *w.* $3 per year. Denver.
M N.....Mechanical News. *s-m.* $1.50. New York.
M R.....Manufacturer's Record. *w.* $4. Baltimore.
M R C...Marine Review. *w.* $2. Cleveland, O.
M Rec....The Marine Record. *w.* $2. Cleveland.
M S P....Mining and Scientific Press. *w.* $3 per year. San Francisco, Cal.
M S R....Mining and Scientific Review. *w.* $2 per year. Denver.
N A R...North American Review. *m.* $5. N. Y.
N B .....National Builder. *m.* $3. Chicago.
N B D. .Northwestern Builder and Decorator. *m.* $2. Minneapolis.
N C B...National Car Builder. *m.* $2. N. Y.
N M ...Northwestern Mechanic. *m.* $1. Minneapolis.
N P R...National Popular Review. *m.* $2.50. Chicago.
N W.....Northwestern Architect. *m.* $3. Minneapolis.
O M......Overland Monthly. *m.* $3 per year. San Francisco.
O P D R..Oil, Paint and Drug Reporter. *w.* $6. N.Y.
P...... ..Paving and Municipal Engineering. *m.* $2 per year. Indianapolis.
P A......Progressive Age. *s-m.* $3. New York.
P D.. ...Painting and Decorating. *m.* $1. Phila.
P E. .....Practical Electricity. *f.* $2 per year. Boston.
P E C P.Proceedings of the Engineers' Club. *q.* $2 Phila.
P Era... Pharmaceutical Era. *s-m.* $2. Detroit.
P L......Pacific Lumberman, Contractor, and Electrician. *w.* $3. San Francisco.
P M. . .Paper Mill. *w.* $3. N. Y.
P R......Pharmaceutical Record. *s-m.* $1.50. N. Y.
P S......Power-Steam. *m.* $1 per year. N. Y.
P S M....Popular Science Monthly. *m.* $5. N. Y.
P S N...Popular Science News. *m.* $1. Boston.
R A.....Railway Age. *w.* $4 per year. Chicago
R C J....Railroad Car Journal. *m.* $1 per year. N. Y.
R G .....Railroad Gazette. *w.* $4.20 per year. N. Y.
R M.....Roller Mill. *m.* $2. Buffalo, N. Y.
R M M..Railway Master Mechanic. *m.* $1. Chicago.
R of R...Review of Reviews. *m.* $2.50. N. Y.
R P......Registered Pharmacist. *w.* $1. Chicago.
R R......Railway Review. *w.* $4 per year. Chicago.
R S P....Rudder, Sail and Paddle. *m.* $2. N. Y.
R T ....Rose Technic. *m.* $1. Terre Haute, Ind.
R & T...Roofer and Tinner. *m.* $1 per year. N. Y.
R'y N....Railway News. *m.* $2. N. Y.
S .. ..Stone. *m.* $2 per year. Indianapolis, Ind.
S A......Southern Architect. *m.* $1. Atlanta.
San......Sanitarian. *m.* $4 per year. Brooklyn.
Sc........Science. *w.* $3.50 per year. New York.
Sc A.....Scientific American. *w.* $3. N. Y.
Sc A S...Scientific American Supplement. *w.* $5. N. Y.
Sc M....Scribner's Magazine. *m.* $3. N. Y.
S E......Stationary Engineer. *w.* $2. Chicago.
Sea......Seaboard. *w.* $2 per year. N. Y.
S Ec.....Social Economist. *m.* $2. New York.
S Era... Sanitary Era. *m.* $1 per year. N. Y.
S J E....Sibley Journal of Engineering. *m.* $2. Ithaca, N. Y.
S M.....Scientific Machinist. *m.* $1.50. Cleveland, O.
So L....Southern Lumberman. *s-m.* $2. Nashville, Tenn.
S M Q.. .School of Mines Quarterly. $2. N. Y.
S P......Sanitary Plumber. *s-m.* $1. N. Y.
S R G....Street Railway Gazette. *w.* $3. Chicago.
S R J....Street Railway Journal. *m.* $4. New York.
S R N. ..Street Railway News. *w.* $3. N. Y.
S R R.. .Street Railway Review. *m.* $2. Chicago.
S S .....Southern States. *m.* $1.50. Baltimore.
S V......Safety Valve. *m.* $1 per year. N. Y.
T... .. .Tradesman. *s-m.* $2. Chattanooga, Tenn.
T A I E E.Transactions American Institute of Electrical Engineers. *m.* $5 per year. N. Y.
T C E....Transactions American Society of Civil Engineers. *m.* $10. N. Y.
T Q......Technology Quarterly. $3. Boston.
W E......Western Electrician. *w.* $3. Chicago.
W F E E.World's Fair Electrical Engineering. *m* $3. Chicago.
W G R..Water and Gas Review. *m.* $1. New York.

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A L ....The Architect. *w.* 26*s*. London.
A M S.. Australian Mining Standard. *w.* 30*s*. per year, postpaid. Sydney, Australia.
B A... .The British Architect. *w.* 23*s*. 8*d*. London.
C G.... ..Colliery Guardian. *w.* 27*s*. 6*d*. per year, post-paid. London.
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D. ..... Discovery. *w.* 8*s*. 8*d*., post-paid. London.
E.........Engineering. *w.* 36*s*., post-paid. London.
E E L....Electrical Engineer. *w.* 17*s*. 4*d*. per year, post-paid. London.
E G......Engineers' Gazette. *m.* 4*s*., post-paid. London.
E L.......Electricity. *w.* 6*s*. 6*d*., post-paid. London.
El.. .....Electrician. *w.* 24*s*. post-paid. London.
Eng L... Engineer. *w.* 36*s*., post-paid. London.
E P......Electrical Plant. *m.* 6*s*. per year, post-paid. London.
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F R......Fortnightly Review. *m.* $4.50 per year. New York. London.
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G W......Gas World. *w.* 13*s*., post-paid. London.
I.........Iron. *w.* 30*s*. per year, post-paid. London.
I & S.....Iron and Steel Trades' Journal. *w.* 25*s*., post-paid. London.
I C B.....Illustrated Carpenter and Builder. *w.* 8*s*. 8*d*. per year, post-paid. London.
I C T.... Iron and Coal Trades' Review. *w.* 30*s*. 4*d*., post-paid. London.
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I Eng....Indian Engineer. *w.* Rs. 15 per year, postage extra. Calcutta.
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Inv......Invention. *w.* 28*s*., post-paid. London.
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J S A....Journal of the Society of Arts. *w.* London.
K.........Knowledge. *m.* 6*s*., post-paid. London.
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M E & E J.Manufacturers' Engineering and Export Journal. *m.* London.
Min W..The Mining World. *w.* 21*s*. post ex. London.
M W.....Mechanical World. *w.* 8*s*. 8*d*. per year, post-paid. London.
N....... Nature. *w.* $7, post-paid. London.
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HYDRAULICS.

11176. The Atlantic Highlands, N. J., Standpipe. Ill. (E R-March 11.) 1400 w.

11177. Estimation of the Loss of Water

Power in a Stream by Taking Water for a City Supply. L. M. Hastings (E R–March 11.) 1800 w.

*11217. A High-Speed Waterworks Pump. Ill. Arthur Rigg (Eng L–March 3.) 1800 w.

†11251. The Water Supply of Philadelphia, with discussion. Henry Leffmann (P E C P–Jan.) 13500 w.

†11257. Construction of the Power House of the Rochester Power Company, Adjacent to Genesee Falls, Rochester, N. Y. Ill. Robert Cartwright (T C E–Jan.) 1800 w.

†11258. The Effect of Tuberculation on the Delivery of a 48-in. Water Main. Ill. James Duane (T C E–Jan.) 2000 w.

11308. Stand-Pipes and Their Design. Ill. Freeman C. Coffin (E N–March 16.) 6000 w.

11337. Iron and Steel Water Tanks. W. C. Coffin, Jr. (E M J–March 18.) 1000 w.

11352. The Protection of the Croton Watershed. Peter Milne (F W–March 18.) 900 w.

†11458. Electrolysis of Water Pipes. C. H. Morse (J N E W–March.) 5500 w.

†11459. The High Service Water Works System of New London, Conn. Ill. Walter H. Richards (J N E W–March.) 3000 w.

†11460. Additional Discussion on "The Arrangement of Hydrants and Water Pipes for Protection of a City against Fire." W. R. Billings, G. H. Benzenberg, W. H. Richards, and J. R. Freeman (J N E W–March.) 6500 w.

†11461. Selection of Sands for a Filter. Allen Hazen (J N E W–March.) 2000 w.

†11462. Experience with Cement Lined Pipes. John C. Haskell (J N E W–March.) 2000 w.

11463. Draining the Okefinokee Swamp (Sc A–March 25.) 700 w.

11489. Utilization of Water Power in Southern India (E N–March 23.) 1100 w.

11510. Some Points about Pumps (S E–March 18) 1400 w.

*11570. Drainage of the Valley of Mexico. Ill. (Eng L–March 17.) 1000 w.

*11609. The Water Power at Great Falls, Montana. Ill. (R M–March.) 750 w.

11618. Reasons Given by the Manufacturers for Objecting to the Meter System (W G R–March.) 2000 w.

11619. Strong Endorsement of the Meter System. George H. Felix (W G R–March.) 800 w.

11620. The Meter System Sustained (W G R–March.) 1800 w.

11632. The 5000 H. P. Turbines for the Niagara Power Plant. Ill. (E N–March 30.) 1500 w.

11635. Cost of Laying Water Pipe. C. D. Barstow (E N–March 30.) 3500 w.

11699. The North Adams Dam. Ill. (E R–April 1.) 500 w.

*11759. The Chicago Exhibition Water Supply. (Eng L–March 24.) 1800 w.

*11769. New Waste Gates at Allington Lock. Ill. (E–March 24.) 600 w.

11787. An Ingenious Water-wheel. Ill. (M & B–March.) 950 w.

*11817. Two Methods of Getting Direct High Pressure from Water-Works Pumps. George A. Ellis (P–April.) 2800 w.

11842. Can the So-Called "Underflow" of the Semi-Arid Region be Utilized for General Irrigation? W. W. Follett (E N–April 6.) 4300 w.

*11851. The True Value of a Water Power. (Am M–April 1.) 1400 w.

Serials.

10988. . Water-Power Utilization. Ill. W. H. Booth (E L–Began Feb. 24—4 parts to date—30 cts. each).

11202. High-Pressure Hydraulic Presses in Iron Works. Ill. R. M. Daelen (E–Began March 3—Ended March 10—2 parts—30 cts. each).

11373. The New Water Filters at Hamburg. Ill. (E R–Began March 18—Ended March 25—2 parts—15 cts. each).

INDUSTRIAL CHEMISTRY.

†11128. A New Process for the Manufacture of Manganese on the Commercial Scale. William H. Greene and William H. Wahl (J F I–March.) 1500 w.

†11645. Spontaneous Conversion of Isoprene into Caoutchouc. William A. Tilden (I R W–March 15.) 400 w.

*11768. Chlorine Recovery. C. F. Townsend (E–March 24.) 2200 w.

Serials.

11049. The Applications of Ozone (E R L–Began Feb. 24—4 parts to date—30 cts. each).

INDUSTRIAL SOCIOLOGY.

11139. Labor in Europe—Its Condition and How Disputes are Dealt With (B J C–March 11.) 1000 w.

11161. The Movement of Coercion. Justice Brewer (R A–March 10.) 2200 w.

*11165. The Practical Teaching of Industrial Economics (J G L–Feb. 28.) 2000 w.

†11248. The Surplus Gains of Labor. J. B. Clark (An A A–March.) 3200 w.

†11259. Thou Art the Man. Mary Steadman Aldis (C R–March.) 2800 w.

†11260. The Unemployed and the Land. Harold E. Moore (C R–March.) 6000 w.

*11274. More Thoughts Concerning Wealth and Wages (J G L–March 7.) 2000 w.

†11327. The Present Depression of Trade—Opinions of Men of Business (F R–March.) 8000 w.

*11365. The Organization of Labor. T. V. Powderly (Ch–April.) 3800 w.

†11476. Russian Jews as Desirable Citizens. Ida M. Van Etten (F–April.) 5000 w.

†11477. Italian Immigrants and Their Enslavement. S. Merlino (F–April.) 3500 w.

†11507. The Discontent of the Farmer. Edward W. Bemis (J P E–March.) 6500 w.

11521. Labor and Strikes. R. W. R (E M J–March 25.) 800 w.

*11581. The Principles and Practice of Voluntary Arbitration. Edgar Farman (A L–March 17.) 6000 w.

11594. Organized Labor and the Law. The Ann Arbor Strike (R A–March 24.) 1300 w.

*11610. Is Competition the Life of Trade? (R M–March.) 700 w.

†11643. Compulsory Arbitration—A Reply to Dr. Abbott. Chester A. Reed (A–April) 3000 w.

11693. Labor and Competition. R. W. R. (E M J–April 1.) 1000 w.

†11707. The Negro as a Mechanic. Robert Lowry (N A R–April.) 2000 w.

11708. Organized Labor and the Law. W. L. W. (R A–March 31.) 850 w.

*11725. The Eight-Hour Day. How Will It Affect Wages? (R R L–March 24.) 1800 w.

11735. Labor Troubles in the Mines. Editorial (M I T–March 30.) 850 w.

LANDSCAPE ENGINEERING.

11247. Formal Gardening: Does It Conflict with the Natural Style? (G & F–March 15.) 1300 w.

11442. Formal Gardening: Where it Can Be Used to Advantage (G & F–March 22.) 1500 w.

MARINE ENGINEERING.

11134. The French Man-of-War "Devastation." Ill. (M Rec–March 9.) 125 w.

†11167. East Indian Railway Steamer Lakshmi. Ill. A. W. Rendell (I E–Feb. 4.) 750 w.

*11169. Electrical Distribution for Marine Purposes (M E–March 1.) 1000 w.

*11185. Marine Boilers. Editorial (E–Feb. 24.) 5200 w.

*11187. The Mercantile Marine in War. Editorial (E–Feb. 24.) 2200 w.

*11199. The British Mercantile Marine. Editorial (E–March 3.) 700 w.

11286. A Valuable Aid to Navigation—The Solarometer (Sea–March 16.) 600 w.

11287. Amended Steamboat Rules (Sea–March 16.) 2000 w.

11289. The Use of Oil at Sea. Ill. (Sc A S–March 18.) 500 w.

11297. Screw Propeller—Easy Method of Measuring the Pitch. Ill. (Ir Age–March 16.) 1600 w.

*11400. Wire Shafts for Steamers (I–March 10.) 500 w.

*11407. The Launching of the Campania and Lucania. Ill. (Eng L–March 10.) 3200.

*11410. Southampton and the American Line of United States Mail Steamers. Ill. (Eng L–March 10.) 2000 w.

*11427. Electric Side-Lights on Ships (El–March 10.) 800 w.

11469. British War Ship Construction (Ir Age–March 23.) 1400 w.

11491. Jetty Harbors of the Pacific Coast. Thomas W. Symons (E N–March 23.) 1300 w.

11497. The Steamship "Fuerst Bismarck," Hamburg-American Line. Ill. (E N–March 23.) 1000 w.

11520. The Engineer and the Modern Steamship (M R C–March 23.) 2000 w.

11533. Description of the Engines for the Steamer "Manitou." Ill. (M Rec–March 23.) 700 w.

*11576. Experimental Apparatus and Shaping Machine for Ship Models. Ill. R. E. Froude (I L–March 17.) 2700 w.

†11705. Shipbuilding Here and Abroad (N A R–April.) 3000 w.

11714. The Accident to the "Noordland" S. S. (Eng–April 1.) 1750 w.

*11757. The Loss of the "Naronic." Ill. Editorial (Eng L–March 24.) 1200 w.

*11778. French Protection against British Shipping (Tr–March 24.) 850 w.

11831. Wilmington's Quadruple Event. Three Launches and a Trial Trip (Sea–April 6.) 2000 w.

11832. Queen of the Chesapeake. The Alabama. Ill. (Sea–April 6.) 1000 w.

11838. The Free Port of Copenhagen (E N–April 6.) 2400 w.

Serials.

8483. Marine Engine Design. W. F. Durand (M R C–Began Dec. 1—4 parts to date—15 cts. each).

10888. Marine Propulsion. Ill. I. McKim Chase (A M–Began March 2—3 parts to date—15 cts. each).

11127. Resistance to Ship's Motion: A Natural Law Newly Discovered. F. M. F. Cazin (J F I–Began March—2 parts to date—45 cts. each).

11215. History of the Cunard Steamship Company. Ill. (Eng L–Began March 3—Ended March 10—2 parts—30 cts. each).

11230. Hints to Intending Sea-going Engineers (M W–Began March 3—Ended March 24—2 parts—30 cts. each).

11307. The American Sailor. Percy W. Thompson (Am S–Began March 16—4 parts to date—15 cts. each).

11392. The Central Marine Engine Works at West Hartlepool. Ill. (E–Began March 10—Ended March 17—2 parts—30 cts. each).

MECHANICAL ENGINEERING

†11125. Duty Trial of a Pumping Engine Built by The George F. Blake Manufacturing Company. Ill. Cecil H. Peabody (J F I–March.) 3500 w.

11149. Copying Machinery. B. F. Spalding (A S–March 11.) 2000 w.

*11229. Variable-Speed Power Transmission. Ill. H. C. Spaulding (M W–March 3.) 1400 w.

†11249. The Distribution of Pressure in Bearings. Ill. Carl G. Brath (P E C P–Jan.) 3800 w.

†11250. Investigation of the Strength of Gear Teeth. Ill. Wilfred Lewis (P E C P–Jan.) 2500 w.

11294. The Strength of Small Chains. Ill. (Ir Age–March 16.) 450 w.

11295. Proportioning a Compound Air Compressor (Ir Age–March 16.) 1000 w.

11347. Defects of Air Compressors. W. J. Jenkins (Eng–March 18.) 900 w.

11349. The "Tool Post Grinder" and Some of Its Uses. Ill. (A M M–March.) 2000 w.

11368. A New Ice Machine. F. van Gerpen (B J C–March 18.) 1000 w.

*11406. The Stanners Closes Steel Works, Wolsingham. Ill. (Eng L–March 10.) 3200 w.

*11424. The German Elmore Works. Ill. Clarence P. Feldmann (El–March 10.) 900 w.

11535. Marvelous Mechanism. Wonderful Timepiece Constructed by a Connecticut Manufactory (B J C–March 25.) 550 w.

11622. Pulverization. Ill. (Sc A S–April 1.) 1800 w.

11625. The Cost and Value of Compressed Air. Frank Richards (A M–March 30.) 1000 w.

*11667. Re-Keying on Eccentric Sheaves in Wheel-Shop. Ill. A. A. Maver (L E–April.) 700 w.

*11668. Causes of Breakage. Editorial (L E–April.) 1400 w.

*11669. Tempering Tools. Ill. W. G. Lottes (L E–April.) 900 w.

*11671. Tools for Blacksmith Work. Material and Its Uses. George F. Hinkins (L E–April.) 1200 w.

11712. The Reese Universal Beam Mill. Ill. (Ir Age–March 30.) 3000 w.

*11728. The Jointing of Cast-Iron Pipes (E L–March 24.) 1000 w.

*11733. The "Cyclone" Dust Collector. Ill. C. V. Boys (I L–March 24.) 2000 w.

†11819. The Modern Traveling Crane. Ill. Alexander E. Outerbridge, Jr. (J F I—April.) 4300 w.

*11850. Mistaken Ideas of Shafting. C. B. Tompkins (Am M–April 1.) 1200 w.

Serials.

11039. Helico-Centrifugal Ventilator (C G–Began Feb. 24—Ended March 3—2 parts—30 cts. each).

11082. Belts.—The Influence of Speed.—Dimensions of Pulleys. Charles A. Hague (E A–Began March 11—2 parts to date—15 cts. each).

11246. Mechanical Engineering Materials. Ill. Edward C. R. Marks (P Eng–Began March 3—2 parts to date—30 cts. each).

11569. The Mannesmann Process of Seamless Tube Rolling. W. H. Barraclough (M W–Began March 17—1 part to date—30 cts).

11654. Core Making. Ill. S. Rolland (I T R–Began March 30—1 part to date—15 cts.)

METALLURGY.

11124. The Electrolytic Refining of Copper.—Translated from the French of M. Hyppolyte Fontaine (E M J–March 11.) 700 w.

11148. Experiments with Foundry Iron and Aluminum. C. G. Taylor (A S–March 11.) 1200 w.

*11207. Manganese.—New Estimation Method (I–March 3.) 800 w.

*11278. A Model Coke Plant —The Oliver Coke Works near Uniontown, Pa. Ill. (C E–March.) 2200 w.

†11301. The Calculation of Lead Blast-Furnace Charges. H. Van F. Furman (S M Q–Jan.) 4400 w.

11333. Steel Making in the South (E M J–March 18.) 1100 w.

11335. The General Arrangement of a Lead Smelting Plant. Ill. H. O. Hofman (E M J–March 18.) 1000 w.

†11380. Traces of a Vanished Industry. John Gifford (P S M–April.) 1500 w.

*11387. An Investigation of Coals for Making Coke in the Semet Solvey Ovens, with the Recovery of Ammonia and Tar; and Remarks on the Sources of Ammonia. J. D. Pennock (C G–March 10.) 2000 w.

*11395. Alloys (E–March 10.) 1300 w.

*11399. Treating Refractory Metals in the Electric Furnace (I–March 10.) 700 w.

*11423. What Is Put into a Blast Furnace. Walter J. May (Inv–March 11.) 1000 w.

11453. Big Castings in Little Foundries. Ill. S. Bolland (F D–March 10.) 2000 w.

11454. Pig Iron.—An Account of the Blast Furnace Process by Which the Ores are Reduced to Pig Iron (F D–March 10.) 1700 w.

11464. The Robinson Rifle. Ill. (M S P–March 18.) 400 w.

11467. About Steel. S. W. Goodyear (A M–March 23.) 2000 w.

11471. The Birmingham Steel Question (Ir-Age–March 23.) 1100 w.

11523. The Cost of Barrel Chlorination. John E. Rothwell (E M J–March 25.) 500 w.

11525. Notes on the Cyanide Process in South Africa. W. G. Shaw (E M J–March 25.) 800 w.

*11584. Notes on Modifications of a Method for the Rapid Estimation of Phosphorus. Walter Macfarlane and Archibald Wilson (I C T–March 17.) 3500 w.

11651. Marquette as a Pig Iron Producer. Richard A. Parker (I T R–March 30.) 4300 w.

11652. Chicago as an Iron Center (I T R–March 30.) 2200 w.

11695. The Campbell Washing Machine as Used on Copper Ores (E M J–April 1.) 1500 w.

11696. The Losses in Dressing Cornish Tin Ores. Ill. (E M J–April 1.) 500 w.

11697. Volumetric Determination of Lead. H. H. Alexander (E M J–April 1.) 700 w.

*11737. Electric Metal-Working Development. Frederick P. Royce (I–March 24.) 3700 w.

*11738. Determination of Phosphorus in Iron and Steel. Adolphe Carnot (I–March 24.) 1000 w.

*11739. Canadian Platiniferous Nickel. F. W. Clarke and Charles Catlett (I–March 24.) 800 w.

*11746. The Recent Movement of Iron and Steel Prices in Germany (C G–March 24.) 1200 w.

*11747. The Probability of Establishing an American Tin-Plate Industry (C G–March 24.) 1200 w.

11790. Shrinkage and Warping of Castings. C. R. Tompkins (M N–April 1.) 1300 w.

*11824. Amalgamating Silver Mill, Santa Ediuwiges, Chihuahua, Mexico. Ill. (I S F–April.) 550 w.

*11826. The Invention of Cast Steel (I S F–April.) 2500 w.

Serials.

9459. The Manufacture of Coke. Ill. John Fulton (C E–Began Jan.—4 parts to date—30 cts. each).

10254. Manganese Steel. Ill. Henry M. Howe (J F I–Began Feb.—Ended March—2 parts— 45 cts. each).

10892. Some Points in Silver Milling by Amalgamation. C H. Aaron (M S P–Began Feb. 25—4 parts to date—15 cts. each).

10971. Resistance of Metals to Shear. H. V. Loss. (A E R J–Began March—2 parts to date—30 cts. each).

11122. Variations in the Milling of Gold Ores.—Otago, New Zealand (E M J–Began March 11—Ended March 18—2 parts—15 cts. each).

11219. The Manufacture of Steel by the Thomas and Gilchrist Process. F. Fordeur (C G–Began March 3—Ended March 17—3 parts—30 cts. each).

11222. The Coking of Coal. M. Rossigneux (C G–Began March 3—Ended March 17—3 parts—30 cts. each).

11466. How to Repair Broken or Cracked Castings. Ill. S. Bolland (A M–Began March 23—2 parts to date—15 cts. each.)

11650. Lake Coke-Making and the Weathering of Connellsville Coal. Edmund C. Pechin (I T R–Began March 30—Ended April 6—2 parts—15 cts. each).

11736. The American Tin-Plate Industry (I–Began March 24—1 part to date—30 cts).

MILITARY ENGINEERING.

*11193. The Mounting of Navy Guns. Editorial (E–Jan. 27.) 1500 w.

*11198. The Navy Estimates. Editorial (E–March 3) 5000 w.

11296. Hydraulic Machinery and Heavy Guns (Ir Age–March 16.) 600 w.

11298. The Schneider Gun Mount. Ill. (Ir Age–March 16.) 600 w.

11310. A Bill to Reorganize the Corps of Civil Engineers, U. S. Navy, with Editorial (E N–March 16.) 1700 w.

*11367. The Year's Development of the New Navy (Ch–April.) 1000 w.

11456. Hiram S. Maxim. Ill. (M N–March 15.) 1800 w.

11480. The Simplex and Huge Torpedoes. Ill. H. C. Vogt (Sc A S–March 25.) 1700 w.

11511. Armor Plate and Projectile Tests (B I S–March 22.) 750 w.

*11583. The Finspong Ordnance Factory (I & S–March 18.) 2400 w.

*11588. The Navy and the Lords." Editorial (E–March 17.) 3500 w.

†11706. How Shall the Pension List Be Revised? R. P. C. Wilson, S. S. Burdett, and W. C. Church (N A R–April.) 6000 w.

*11752. Shells with High Explosives. Ill. (A E R J–April.) 1400 w.

*11758. The Bearing of Recent Plate Trials on Future Warfare. Editorial (Eng L–March 24.) 1200 w.

*11760. The Russian Official Report on the Ochta Competition. Ill. (Eng L–March 24.) 1000 w.

Serials.

8241. Assault and Battery. Ill. A. Ewbank (I E–Began Oct 22—Ended Feb. 25—15 parts—45 cts. each).

10738. The Development of American Armor Plate. Ill. F. Lynwood Garrison (M–Began Feb. 15—2 parts to date—30 cts. each).

10957. Chinese Curios. Edward Bedloe (A A–Began March 4—Ended March 11—2 parts—15 cts. each).

11470. Trial of the Dynamite Gunboat "Vesuvius" (Ir Age—Began March 23—Ended March 30—2 parts—15 cts. each).

MINING.

*11103. The Gold Fields of Dutch Guiana. Ill. A. I. Mather (E Mag–May.) 3000 w.

11112. "The Coal Fields of Texas." W. F. Cummins (M R–March 10.) 1500 w.

11121. The Albert Silver Mine, South Africa. Ill. (E M J–March 11.) 1000 w.

11123. The Occurrence of Manganese Ore in Veins. Edward Halse (E M J–March 11.) 1800 w.

*11220. Costs of Coal and Ore Washing. Walter J. May (C G–March 3.) 3500 w.

*11221. Restricted Production (C G–March 3.) 1000 w.

11223. Notes on the Formation of the Iron Ores. James D. Robertson (Sc–March 10.) 800 w.

*11262. The New Kohinoor Gold and Silver

Mine (N. S. W.) Ill. (A M S-Jan. 28.) 2000 w.

*11263. Platinum Deposits at Broken Hill. J. B. Jaquet (A M S-Jan. 28.) 2500 w.

*11276. The Lead and Zinc Mines of Southwest Missouri—A Description of the Ore Formations, and the Primitive Methods of Mining. F. C. Florance (C E-March.) 1200 w.

*11277. Gold Mining in the West. John Robertson (C E-March.) 1400 w.

*11279. Grades for Haulage and Drainage. Richard Lewis (C E-March.) 1100 w.

*11281. 1800 Pounds Equal 1 Ton, According to the Rules of New York Coal Yard Proprietors. H. Barring (C E-March.) 4800 w.

*11283. Advantageous Construction of the Transit and Its Tripod. Ill. Otto C. Burkhart (C E-March.) 1300 w.

*11284. The Use and Characteristics of Explosives Used in Metal Mining. M. C. Ihlseng (C E-March.) 1100 w.

11293. The Boom in Coal Lands (P A-March 15.) 900 w.

†11303. Notes on the Huanchaca Mine, Bolivia, S. A. Robert Peele, Jr. (S M Q-Jan.) 1100 w.

11304. The Situation at Cœur D'Alene (M S P-March 11.) 1300 w.

11306. A California Mine Owned by Ladies (M S P-March 11.) 800 w.

11317. The Lease or Tribute System of Mining as Practised in Colorado. Benjamin B. Lawrence (E N-March 16.) 900 w.

11323. Cuban Iron Ores. Edmund C. Pechin (I T R-March 16.) 2700 w.

11334. Draining Dip Workings. Ill. H. F. Bnlman (E M J-March 18.) 2000 w.

11357. A New Process to Utilize Coal Refuse (M R-March 17.) 1000 w.

11372. Rico and the Enterprise Mine. Ill. (M I T-March 16.) 3500 w.

11378. Profits in Coal Mining (T-March 15.) 900 w.

*11382. Electric Light Switches for Use in Mines. Sydney F. Walker (C G-March 10.) 1800 w.

*11384. The Costs of Handling Ore and Coal. Walter J. May (C G-March 10.) 800 w.

*11434. Opals (A M S-Feb. 11.) 1200 w.

*11438. The Victory Gold Mine, Charters Towers (Q.) (A M S-Feb. 18) 900 w.

*11440. The Broken-Hill Proprietary Company (A M S-Feb. 18.) 1200 w.

11472. The Styrian Magnesite Deposit (Ir Age-March 23.) 650 w.

11517. Labor Department Report on the Phosphate Industry (M R-March 24.) 1000 w.

11522. The Norfolk and Western-Pocahontas Combine (E M J-March 25.) 1200 w.

11524. The Coal Washing Plant at Brookwood, Ala. Ill. (E M J-March 25.) 700 w.

*11549. Coal Mining in Wyoming. William Job (C G-March 17.) 1200 w.

*11556. Tubbing for Pit Shafts. Ill. A Mining Engineer (P Eng-March 17.) 600 w.

*11558. Charters Towers Goldfield. Facts and Opinions of a Recent Visitor (Min W-March 18.) 1500 w.

*11559. Gold Mining in India. A. Mervyn Smith (Min W-March 18.) 2200 w.

11623. Neglect of the Mining Industry in California. Old Californian (M S P-March 25.) 800 w.

11624. "Machine" Mining in Wyoming (M S P-March 25.) 700 w.

11653. Soft Ore Mining on Lake Superior. Per Larsson (I T R-March 30.) 1300 w.

11694. The Coal Fields of Vancouver Island. James Ormiston (E M J-April 1.) 450 w.

*11748. Determination of the Calorific Power of Various Coals, with Abstraction of the Vaporization and Hygroscopic Water. Pierre Mahler (C G-March 24.) 800 w.

*11803. An Exception to the Rule—An Occurrence of Coarse Conglomerate above the Mammoth Anthracite Bed. Benjamin Smith Lyman (C E-April.) 1500 w.

*11805. The Examination of Mine Inspectors and Mine-Foremen. Editorial (C E-April.) 550 w.

*11807. Calculations Pertaining to Hoisting Appliances. F. W. Ewald (C E-April.) 1000 w.

11843. Electrical Coal Mining (E N-April 6.) 2500 w.

11848. The Indiana Gas Field. A. A. A. (I T R-April 6.) 1300 w.

Serials.

8520. Notes on Ironstone Mining in Cleveland. J. C. I'Anson (E-Began Nov. 25—2 parts to date—30 cts. each).

9003. Diamonds in India. A Rechauffée. W. King (I E-Began Nov. 19—4 parts to date—45 cts. each).

10478. The Denbighshire Coalfield. M. E. (C G-Began Feb. 3—3 parts to date—30 cts. each).

10584. Scientific Phases of Mining. Albert Williams, Jr. (Ch-Began March—Ended April—2 parts—30 cts. each).

10645. Croydon (N. Q.) (A M S—Began Jan. 14—3 parts to date—30 cts. each).

10978. The Lührig Process of Washing and Testing Coal. James I'Anson (I-Began Feb. 24—Ended March 3—2 parts—30 cts. each).

11282. Mine Ventilation Made Easy. W. Fairley (C E-Began March—2 parts to date—30 cts. each).

11285. Theories Regarding the Origin of Ore Deposits. Ill. Arthur Lakes (C E-Began March—Ended April—2 parts—30 cts. each).

11385.—Selecting and Calculating a Fan, with Tests of Rateau Fans. M. Rateau (C G-Began March 10—2 parts to date—30 cts. each).

11386. Correlation of the Coalfields in the North of France and South of England. Marcel Bertrand (C G-Began March 10—Ended March 17—2 parts—30 cts. each).

11433. The Hillgrove Mines (A M S–Began Feb. 4—3 parts to date—30 cts. each).

11436. Dalmorton (A M S—Began Feb. 11—2 parts to date—30 cts. each).

11537. Natural Gas. John Young (A M & I W–Began March 24—2 parts to date—15 cts. each).

11574. The Mineral Resonrces of the Southern States. Ill. (I L–Began March 17—1 part to date—30 cts).

11801. Information to Aid in the Search for Gold and Silver. Ill. Arthur C. Lakes (C E–Began April—1 part to date—30 cts).

11804. Fire-Damp. H. Le Chatelier. Translated by H. H. Stock (C E–Began April—1 part to date—30 cts).

11820. From Mine to Furnace. John Birkinbine (J F I–Began April—1 part to date—45 cts).

RAILROADING.

*11101. The Gravity System of Rapid Transit. Benj. S. Henning (E Mag–May.) 3000 w.

*11104. The Cost of Street-Railway Building. T. William Harris (E Mag–May.) 3000 w.

11113. Neatness and Economy at Small Stations. G. C. H. (R G–March 10.) 1100 w.

11114. A Bridge Accident in Massachusetts.—The Accident which Occurred on the Fitchburg Railroad, Feb. 11, 1892. George E. Swain (R G–March 10.) 2500 w.

11115. Union Passenger Station at Portland, Oregon. Ill. (R G–March 10.) 600 w.

11116. Draft Rigging. Chicago, Burlington and Quincy Box Cars. Ill. (R G–March 10.) 600 w.

11118. A Hard Winter and Heavier Rails. C. P. Sandberg (R G–March 10.) 700 w.

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11797. Electric Heater for Cars. Ill. (S R N–April 1.) 1400 w.

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9254. Railway Management. Horace Cope (R R–Began Dec. 31—4 parts to date—15 cts. each).

9689. Railroad Car Design. Ill. Archer Richards (R C J–Began Jan.—2 parts to date—15 cts. each).

10378. The Evolution of the Railroad Turntable. Ill. C. A. Greenleaf (R G–Began Feb. 10—3 parts to date—15 cts. each).

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11184. The Berne Compressed Air Tramway. Ill. C. S. DuRiche Preller (E–Began Feb. 24—Ended March 3—2 parts—30 cts. each).

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†11255. Flood Waves in Sewers and Their Automatic Measurement, with Discussion. Ill. Alva J. Grover (T C E–Jan.) 2000 w.

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8127. Ventilation and Heating. J. S. Billings (E R–Began Nov. 19—6 parts to date—15 cts. each).

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†11164. Tests on the Triple Engine at the Massachusetts Institute of Technology. Ill. C. H. Peabody and E. F. Miller (T Q–Oct.) 2200 w.

*11231. Piston Rod Packings (M W–March 3.) 1000 w.

†11254. The Development of the Injector. Ill. Strickland L. Kneass (P E C P–Jan.) 2600 w.

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*11479. Economy of Automatic Engines. Ill. R. H. Thurston (S J E–March.) 1800 w.

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*11775. Heat Movement in Steam Engine Cylinders (E R L–March 24.) 1300 w.

11776. Circulation of Water in Steam Boilers. Ill. Criticisms of G. H. Babcock's lecture. Fritz Kranss and John J. Hogan (P S–April.) 7500 w.

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10946. Hints. W. H. Wakeman (M G–Began March 4—Ended March 11—2 parts—15 cts. each).

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11102. Progress in Steam Engineering. R. H. Thurston (E Mag–Began May—1 part to date—30 cts).

11138. Notes on the Steam Injector. Strickland L. Kneass (E M–Began March—1 part to date—30 cts).

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11720. Steam Boilers.—How they may be safely operated and economically handled (T–Began April 1—1 part to date—15 cts).

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11499. Prof. Elisha Gray and the Telautograph. Ill. (E W–March 25.) 4400 w.

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11661. Telephonic Communication without a Special Line. G. Mareschal (W E–April 1.) 400 w.

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11784. Annual Report of the American Bell Telephone Company (E W–April 8.) 1800 w.

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*11100. Cotton as a Factor in Progress. Ill. D. A. Tompkins (E Mag–May.) 3000 w.

11110. Tobacco Culture in the South (M R–March 10.) 2500 w.

11111. Rubber From Cotton Seed Oil. C. B. Warrand (M R–March 10.) 800 w.

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11173. The Problem of Heating Houses. C. M. (A A–March 11.) 1400 w.

*11191. The Future of British Engineering. Charles S. Du Riche Preller (E–Jan. 27.) 3000 w.

*11211. Industrial Diseases and Their Prevention. Editorial (I L–March 3.) 1600 w.

*11212. Diseases Incidental to Work-People in Chemical and Other Industries.—Abstract of Lecture by Watson Smith (I L–March 3.) 1500 w.

*11216. The Dynamics of Gravity; or Gravity Viewed as a Dimensional Property of a Gas. S. Tolver Preston (Eng L–March 3.) 1600 w.

†11253. Paint as Used in Engineering Constructions. Edward Hurst Brown (P E C P–Jan.) 4500 w.

11338. Some Misconceptions Concerning Asbestos. J. T. Donald (E M J–March 18.) 800 w.

*11364. Eccentric Features of the World's Fair. John C. Eastman (Ch–April.) 1700 w.

*11393. Mechanical Flight. Editorial (E–March 10.) 2000 w.

*11409. Radiant Heat. Editorial (Eng L–March 10.) 1300 w.

†11478. An English View of Investments in the United States. R. H. Inglis Palgrave (A–April.) 4000 w.

†11508. The Crisis of 1890. Max Wirth (J P E–March.) 9000 w.

11519. The Economical Operation of an Ice Factory (M R–March 24) 900 w.

*11571. Mechanical Flight. Ill. Hiram S. Maxim (Eng L–March 17.) 1500 w.

*11577. Industrial Diseases and Their Prevention. A. C. (I L–March 17.) 1200 w.

†11644. The Decay of India-rubber. Henry J. Williams (I R W–March 15.) 1500 w.

11646. Southern States and Cotton Manufacture. J. S. Jeans (S S–March.) 1800 w.

11647. The State of Georgia. Ill. Articles by R. T. Nesbitt, J. W. Spencer, C. J. Haden, Henry R. Goetchius, H. H. Hickman, S. D. Bradwell, I. W. Avery, Walter Pope, and Frederic Jewett Cooke (S S–March.) 18500 w.

11648. Southern Prospects for English Capital (S S–March.) 1500 w.

11649. How the South Stands a Crisis. Edward H. Sanborn (S S–March.) 2800 w.

11657. How the South Needs More Factories. Extract from a Speech by Mr. Bowser (M R–March 31.) 1800 w.

11658. A Significant Move in Immigration (M R–March 31.) 650 w.

*11670. Heat and Combustion. Angus Sinclair (L E–April.) 2800 w.

†11686. Great Falls, Montana. Ill. (S R J–April.) 3000 w.

*11702. The Birth of a Profession. J. B. Johnson (J A E S–Feb.) 3000 w.

*11704. Character in the Engineering Profession. Isham Randolph (J A E S–Feb.) 2000 w.

11715. Another Flying Machine (Alleged)—The Invention of S. P. Langley (Eng–April 1.) 1200 w.

*11734. The Outlook for Trade and Industry. Editorial (I L–March 24.) 1400 w.

*11745. The Manufacture of Peat as Fuel (C G–March 24.) 2500 w.

11762. Diminution of Fire Hazard Since the Introduction of Electricity. John McGhie (F W–April 1.) 2000 w.

*11770. Engineering Theory and Practice. Editorial (E–March 24.) 1800 w.

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11786. A New Development of the Art of Glass Painting (M & B–March.) 600 w.

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*11799. Burning of Mineral Oil. John Laing (G W–March 25.) 2200 w.

11810. Courtesy as an Incentive to Good Work. Greko (A M–April 6.) 1800 w.

11812. Hawaii. Ill. Frank H. Palmer (Sc A S–April 8.) 2200 w.

*11816. The Evolution of the Brick Machine. Cyrus Chambers, Jr. (P–April.) 5500 w.

*11830. Heating a Residence. K. (B & D–March.) 2200 w.

11844. Some Valuable Products from Sharks. C. B. Warrand (M R–April 7.) 800 w.

11846. The Possible Utilities of Cotton-seed (M R–April 7.) 550 w.

Serials.

9401. World's Columbian Exposition. Ill. (E N–Began Jan. 5—6 parts to date—15 cts. each).

9745. American Industries and British Commerce (E–Began Jan. 6—11 parts to date—30 cts. each).

10535. Notes from the Engineering Schools (E N–Began Feb. 16—5 parts to date—15 cts. each).

11346. Historical Notes upon Early American Engineers and Their Work. Hale G. Robinson (Eng–Began March 18—2 parts to date—15 cts. each).

11678. Hot Air Heating. Ill. (Met W–Began April 1—1 part to date—15 cts).

11821. Causes of Fires. C. John Hexamer (J F I–Began April—1 part to date—45 cts).

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THE TECHNICAL INDEX.

A CATALOGUE OF LEADING ARTICLES PUBLISHED CURRENTLY IN THE TECHNICAL JOURNALS OF THE UNITED STATES AND GREAT BRITAIN.

THIS publication has been aptly described as "the greatest step that has been taken in recent years towards systematizing work" for the engineer, the architect, the electrician, the railway manager, and the business man. The list of publications regularly indexed will show that it covers a world-wide range of the best technical literature, and all the articles are so conveniently classified under general headings that within a few minutes an active man can learn of everything that has been published during the month in relation to his special lines of investigation. In short, it is to the practical man just what Poole's celebrated Index to periodicals has long been to the literary worker, but with this essential difference,—namely, that in addition to indicating *just where* leading articles have been published, *we undertake to supply copies of the articles themselves.* The unparalleled convenience and economy of this double service can readily be appreciated.

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[In the body of the index only the initials of the journals quoted are given, and these can be readily identified by the following list of periodicals. Other abbreviations are: Ill=illustrated. W=words.]

THE AMERICAN PRESS.

A ....Arena. *m.* $5 per year. Boston.
AA......American Architect. *w.* $6. Boston.
An A A..Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
A An.... American Analyst. *f.* $1 per year. N. Y.
A Ar.....American Artisan. *w.* $2. Chicago.
A & B....Architecture and Building. *w.* $6. N. Y.
A B M...Architect, Builder, and Manufacturer. *m.* $1.50. Kansas City, Mo.
A C J....Am. Chemical Journal. *b-m.* $4. Baltimore.
A D... ..American Druggist. *m.* $1.50. New York.
A E .....Architectural Era. *m.* $3. N. Y.
A E R J.American Engineer and Railroad Journal. *m.* $3. New York.
A G......Am. Geologist. *m.* $3.50. Minneapolis.
A G L J..Am. Gas Light Journal. *w.* $3. New York.
A H......Annals of Hygiene. *m.* $2 per year. Phila.
A J Phar.Am. Journal of Pharmacy. *m.* $3. Phila.
A J R A..Journal of Railway Appliances. *m.* $2 per year. New York.
A M......American Machinist. *w.* $3. New York.
A M & I W.American Manufacturer and Iron World. *w.* $4 per year. Pittsburg.
Am A....American Agriculturist. *m.* $1.50. N.Y.
Am G....American Gardening. *m.* $1. N. Y.
A M M...American Mechanics. *m.* $1. Minneapolis.
Am M....American Miller. *m.* $2. Chicago.
Am S....American Shipbuilder. *w.* $2. N. Y.
A & N J..Army and Navy Journal. *w.* $6. New York.
A & N R..Army and Navy Register. *w.* $3 per year. Washington.
A R......Architectural Record. *q.* $1. New York.
A Rev....Architectural Review. *s-q.* $5. Boston.
A S .....Age of Steel. *w.* $3. St. Louis.
B B......Brick Builder. *m.* $2.50. Boston.
B C......Boston Commonwealth. *w.* $2.50.
B & D ...The Builder and Decorator. *m.* $2. Minneapolis.
B G S .. Bulletin of the American Geographical Society. *q.* $5. N. Y.
B I S.....Bulletin of American Iron and Steel Association. *w.* $4. Phila.
B J C....Boston Journal of Commerce. *w.* $3 per year. Boston.
B P .....Bulletin of Pharmacy. *m.* $1. Detroit.
B & W...Builder and Woodworker. *m.* $1. N. Y.
C....... .Compass. *m.* $1 per year. New York.
C A......Calif. Architect. *m.* $3. San Francisco.
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C E N... Canadian Electrical News. *m.* $1 per year. Toronto.
Ch.......Chautauquan. *m.* $2. Meadville, Pa.
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D Jour. .Druggists' Journal. *m.* $1. Chicago.
E A......Electrical Age. *w.* $3 per year. New York.
E E N Y..Electrical Engineer. *w.* $3 per year. N. Y.
E I.......Electrical Industries. *m.* $3. Chicago.
E M......Engineering Mechanics. *m.* $2. Phila.
E Mag...Engineering Magazine. *m.* $3. New York.
E M J....Engineering and Mining Journal. *w.* $4 per year. New York.
E N......Engineering News. *w.* $5 per year. N. Y.
Eng .....Engineer. *s-m.* $2 per year. New York.
E N Y....Electricity. *w.* $2.50. N. Y.
EP D....Electrical Progress and Development. $2. Boston.
E R......Engineering Record. *w.* $5. N. Y.
E & R ...Electricity and Railroading. *m.* $1 per year. Boston.
E R N Y..Electrical Review. *w.* $3 per year. N. Y.
E S W P...Proceedings of Engineers' Society of W. Penn. *m.* $7. Pittsburgh.
E W......Electrical World. *w.* $3 per year. N. Y.
F ....Forum. *m.* $5 per year. New York.
F D......The Foundry. *m.* $1. Detroit.
F W .....Fire and Water. *w.* $3 per year. N. Y.
G & F....Garden and Forest. *w.* $4 per year. N.Y.
G G M...Goldthwaite's Geographical Magazine. *m.* $2 per year. N. Y.
G R......Good Roads. *m.* $2 per year. N. Y.
I A......Inland Architect. *m.* $5 per year. Chicago.
I Age....Inventive Age. *s-m.* $1. Washington.
Ir Age..Iron Age *w.* $4.50. N. Y.
I I G....The Iron Industry Gazette. *m.* $1.50. Buffalo.
I R W...India Rubber World. *m.* $3 per year. N. Y.
I S F.....Industry. *m.* $2 per year. San Francisco.
I T R....Iron Trade Review. *w.* $3. Cleveland.
J A... ..Journal of Architecture. *m.* $2. Phila.
J A C S..Journal of the American Chemical Society. *m.* $5 per year. N. Y.

J A E S..Journal of the Association of Engineering Societies. *m.* $3 per year, Chicago.
J F I ....Journal of the Franklin Institute. *m.* $5 per year. Philadelphia.
J M S I..Journal of the Military Service Institution. *b-m.* $4 per year. Governor's Island, N. Y. H.
J N E W.Journal of the N. E. Waterworks Association. *q.* $2. New London, Conn.
J P E.....Journal of Political Economy. *q.* $3. Chicago.
J U S A..Journal of the United States Artillery. *q.* $2.50. Fort Monroe, Va.
L E......Locomotive Engineering. *m.* $2. N. Y.
L M......Leather Manufacturer. *m.* $3. N. Y.
L Mag...Lippincott's Magazine. *m.* $3. Phila.
L P......Louisiana Planter. *w.* $3. New Orleans.
M & B...Manufacturer and Builder. *m.* $1.50. N. Y.
M & El...Mechanic and Electrician. *w.* $2 per year. St. Louis.
Met W...Metal Worker. *w.* $2 per year. N. Y.
M G......Manufacturer's Gazette. *w.* $2.50. Boston.
Min .....Minerals. *m.* $1 per year. N. Y.
M I T....Mining Industry and Tradesman. *w.* $3 per year. Denver.
M N.....Mechanical News. *s-m.* $1.50. New York.
M R......Manufacturer's Record. *w.* $4. Baltimore.
M R C...Marine Review. *w.* $2. Cleveland, O.
M Rec....The Marine Record. *w.* $2. Cleveland.
M S P....Mining and Scientific Press. *w.* $3 per year. San Francisco, Cal.
M S R....Mining and Scientific Review. *w.* $2 per year. Denver.
N A R...North American Review. *m.* $5. N. Y.
N B .....National Builder. *m.* $3. Chicago.
N B D. .Northwestern Builder and Decorator. *m.* $2. Minneapolis.
N C B...National Car Builder. *m.* $2. N. Y.
N M ...Northwestern Mechanic. *m.* $1. Minneapolis.
N P R...National Popular Review. *m.* $2.50. Chicago.
N W.....Northwestern Architect. *m.* $3. Minneapolis.
O P D R..Oil, Paint and Drug Reporter. *w.* $6. N.Y.
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P R......Pharmaceutical Record. *s-m.* $1.50. N. Y.
P S .....Power-Steam. *m.* $1 per year. N. Y.
P S M....Popular Science Monthly. *m.* $5. N. Y.
P S N...Popular Science News. *m.* $1. Boston.
R A.....Railway Age. *w.* $4 per year. Chicago
R C J....Railroad Car Journal. *m.* $1 per year. N. Y.
R G .....Railroad Gazette. *w.* $4.20 per year. N. Y.
R M.....Roller Mill. *m.* $2. Buffalo, N. Y.
R M M..Railway Master Mechanic. *m.* $1. Chicago.
R of R...Review of Reviews. *m.* $2.50. N. Y.
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R R......Railway Review. *w.* $4 per year. Chicago.
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R & T...Roofer and Tinner. *m.* $1 per year. N. Y.
R'y N....Railway News. *m.* $2. N. Y.
S... .....Stone. *m.* $2 per year. Indianapolis. Ind.
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Sc A S ...Scientific American Supplement. *w.* $5. N. Y.
Sc M....Scribner's Magazine. *m.* $3. N. Y.
Sc Q... Scientific Quarterly. *qr.* $2. Golden, Col.
S E .....Stationary Engineer. *w.* $2. Chicago.
Sea......Seaboard. *w.* $2 per year. N. Y.
S Ec.....Social Economist. *m.* $2. New York.
S Era... Sanitary Era. *m.* $1 per year. N. Y.
S J E....Sibley Journal of Engineering. *m.* $2. Ithaca, N. Y.
S M.....Scientific Machinist. *m.* $1.50. Cleveland, O.
So L.....Southern Lumberman. *s-m.* $2. Nashville, Tenn.
S M Q.. .School of Mines Quarterly. $2. N. Y.
S R E N.Street Railway Electrical News. *m.* $2. Minneapolis.
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S R N. ..Street Railway News. *w.* $3. N. Y.
S R R.. .Street Railway Review. *m.* $2. Chicago.
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S V......Safety Valve. *m.* $1 per year. N. Y.
T ... .Tradesman. *s-m.* $2. Chattanooga, Tenn.
T A I E E.Transactions American Institute of Electrical Engineers. *m.* $5 per year. N. Y.
T C E....Transactions American Society of Civil Engineers. *m.* $10. N. Y.
T Q......Technology Quarterly. $3. Boston.
W E.. ...Western Electrician. *w.* $3. Chicago.
W F E E.World's Fair Electrical Engineering. *m.* $3. Chicago.
W G R..Water and Gas Review. *m.* $1. New York.

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Inv ..Invention. *w.* 28*s.*, post-paid. London.
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R R L...The Railway Review. *w.* London.
R W......Railway World. *m.* $3, post-paid. London.
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12548. Commercial Advancement of Electrical Interests. W. H. McKinlock (W E–May 6.) 1000 w.

†12581. The Migration of the Ions. Ill. George Flowers Stradling (J F I–May.) 2000 w.

12611. Recent Developments in the Electrical Transmission of Power. C. J. H. Woodbury (B J C–May 6.) 3000 w.

*12617. Works of the National Electric Manufacturing Company. Ill. (S R E N–April.) 1400 w.

*12630. The Efficiency of Dynamos. Sydney F. Walker (C G–April 28.) 1900 w.

*12650. Terminals. J. Rennie (E E L–April 28.) 1500 w.

12667. The Proposed New Units. J. R. Rosebrugh (E W–May 13.) 1200 w.

12669. The Electrical Fountains at the World's Fair. Ill. (E W–May 13.) 6000 w.

12674. Electrical Engineering Plant at McGill University. Ill. (E E N Y–May 10.) 1000 w.

Serials.

3500. Theoretical Elements of Electro-Dynamic Machinery. Ill. A. E. Kennelly (E E N Y-Began April 20, 1892—18 parts to date —15 cts. each).

9771. What is Electricity? S. F. Walker (E E L-Began Jan. 6—4 parts to date—30 cts. each).

9858. The Calculation of Alternating Current Motors. Ill. E. Arnold (E W-Began Jan. 21 —3 parts to date—15 cts. each).

10464. The Silver Plating Industry. Ill. (I L-Began Feb 3—3 parts to date—30 cts. each).

10843. Conductors and Insulators. Ill. Reginald A. Fessenden (E W-Began March 4—5 parts to date—15 cts. each).

11129. Some Principles that Must Be Observed in Order to Make a Good Closed Circuit Battery, and a New Portable Dry Cell Described in which These Principles Are Applied. Ill. E. F. Northrup (J F I-Began March—Ended May—3 parts—45 cts. each).

11501. Theory of the Transformer. Ill. F. Bedell and A. C. Crehore (E W-Began March 25—3 parts to date—15 cts. each).

11560. Electricity as a Motive Power. Albion T. Snell (El-Began March 17—4 parts to date —30 cts. each).

11913. Comparative Tests of Hellesen and E. C. C. Dry Battery Cells. Ill. Prof. Jamieson (E R L-Began March 31—Ended April 7—2 parts—30 cts. each).

11966. Electricity as a Factor in National Economy (E L-Began March 31—Ended April 14—3 parts—30 cts. each).

12014. The Standardizing of Electrical Instruments. Ill. W. M. Hill (E W-Began April 15—2 parts to date—15 cts. each).

12105. Parallel Distribution. Ill. Francis Jehl (El-Began April 7—Ended April 14—2 parts—30 cts. each).

12311. On Lightning Rods (E R L-Began April 14—1 part to date—30 cts).

12514. The Condenser in Alternate Current Power Distribution. Ill. William Paul, Jr. (E E N Y-Began May 3—2 parts to date—15 cts. each).

12668. Non-Synchronous Alternating Current Motors. Dr. Behn-Eschenburg (E W-Began May 13—1 part to date—15 cts).

ELECTRIC LIGHTING.

*11858. Fire-Risks in Electric Insulation. F. A. C. Perrine (E Mag-June) 3000 w.

11984. The Alternating Current Plant at Clermont-Ferrand. Ill. (E N Y-April 12.) 900 w.

*11992. The Manufacture of Arc-Lamp Carbons. Editorial (E P-April 1.) 600 w.

12010. The Incandescent Lamp Situation. F. S. Terry (E W-April 15.) 1500 w.

12011. Municipal Electric Plant in Berne, Switzerland (E W-April 15.) 1400 w.

12016. An Interesting Point. A. B. Upham (E W-April 15.) 500 w.

12017. The Ball System of Electric Lighting. Ill. (E A-April 15.) 2000 w.

*12108. A Secondary Standard for Arc-Light-Photometry. Ill. (El-April 7.) 1850 w.

*12121. The Day Load. Editorial (E R L-April 7.) 1000 w.

*12123. Arc Lamps v. Large Incandescent Lamps for Street Lighting. Sydney F. Walker (E R L-April 7.) 1700 w.

*12124. Joint-Boxes on Under-ground Networks. Ill. (E R L-April 7.) 3000 w.

*12134. The Incandescent Illumination at the World's Fair. Ill. R. H. Pierce (W F E E-April.) 2000 w.

*12137. Underground Electric Mains in Paris. Ill. (E E L-April 7.) 1300 w.

12174. The New Sunbeam Incandescent Lamp. Ill. (E E N Y-April 19.) 750 w.

12175. Recent Improvements in Stopper Lamps—The Benjamin and the Green. Ill. (E E N Y-April 19.) 650 w.

12186. First Annual Report of the General Electric Company (E A-April 22.) 3000 w.

12188. Early History of the Manufacture of the Goebel Lamp. Ill. C. F. Dunderdale (E R N Y-April 22.) 1250 w.

12189 The Columbia Lamp Case. Ill. (E R N Y-April 22.) 1300 w.

12229. A. S. Terry on the Lamp Question (E W-April 22.) 1360 w.

12233. The Central Station of the Akron General Electric Company. Ill. (E W-April 22.) 1600 w.

12287. Columbia Company Wins—Edison Company Refused an Injunction by Judge Hallett (W E-April 22.) 1650 w.

*12348. A Cable Rupture. Ill. Harris J. Ryan (S J E-April.) 1700 w.

12355. The Stanley-Kelly Two-Phase Alternating Motor. Ill. (E E N Y-April 26.) 2500 w.

12357. Paper Insulated Wire and Its Manufacture. Ill. (E E N Y-April 26.) 950 w.

12358. Gas Glow Burners vs. Giessler Tube Light (E R N Y-April 29.) 800 w.

12361. Effect of Hallett's Decision (E W-April 29.) 2100 w.

12376. Incandescent Lamp Patents (E N-April 27.) 600 w.

*12426. Some Economic Points in Connection with Electricity Supply. Gisbert Kopp (J S A-April 21.) 7000 w.

*12428. Concentric Wiring. Sam Mavor (El-April 21.) 1000 w.

*12441. Marine Electric Lighting. Ill. (E P-Jan. 1.) 63000 w.

12482. Henry Goebel. Ill. (E W-May 6.) 1350 w.

*12511. Municipal Ownership of Street Lighting Plants (P-May.) 1000 w.

12537. Electricity in the Naval Review. Ill. (E N Y-May 3.) 2500 w.

*12651. Notes on the Cost of Electric Lighting. F. B. Nicholson (E E L-April 28.) 2000 w.

12666. Sensational Charges Against the General Electric Company (E W–May 13.) 1500 w.

Serials.

6709. Electric Light and Power. Arthur F. Gny (E E L–Began Sept 9—19 parts to date—30 cts. each).

9906. Electric Light and Gas. Ed. C. De Segundo (E R L–Began Jan. 13—Ended March 31—4 parts—30 cts. each).

10844. The Design of a Central Station for Incandescent Electric Lights (E W–Began March 4—3 parts to date—15 cts. each).

11245. The Specification of Electric Plant and Mains for Open Competition. Thomas Tomlinson (E R L–Began March 3—Ended April 7—3 parts—30 cts. each).

11836. Can a Practical All Solid Incandescent Lamp without Vacuum Be Made? F. M. F. Cazin (E A–Began April 8—Ended April 22—2 parts—15 cts. each).

12230. The Story of the Evolution of the Edison Incandescent Lamp. Ill. (E W–Began April 22—2 parts to date—15 cts. each).

GAS ENGINEERING.

*11895. An Unconsidered Source of Error in Practical Photometry. H. Leicester Greville (J G L–March 28.) 1500 w.

*11995. The Comparative Cost of Gas and Electric Lighting. J. M. Turnbull (J G L–April 4.) 2800 w.

12030. Elevating a 24-Inch Gas Main. Ill. J. B. Crockett (E N–April 13.) 2300 w.

12071. Governor Burners, with Discussion. Irwin Butterworth (P A–April 15.) 6000 w.

12072. Oils for Gas Enriching, with Discussion. Allen S. Miller (P A–April 15.) 3500 w.

*12102. Cyanogen in Gas Purification Oxide (G W–April 8.) 500 w.

*12258. Conveyors and Elevators for Gas-Works Purposes. Ill. (J G L–April 11.) 1500 w.

*12259. Experimenting with a View to the Development of Gasholder Construction. E. Lloyd Pease (J G L–April 11.) 850 w.

*12269. Gasworks' Plant for the Continent and the Colonies (G E M–April 10.) 4000 w.

*12270. Inaugural Address of E. C. Riley (G W–April 15.) 5000 w.

*12271. Notes on the Manufacture of Gas. W. Stagg (G W–April 15.) 2600 w.

*12469. The Hawkite Hydrogen Gas Process (G W–April 22.) 800 w.

*12565. F. T. C. Linton on Oil-Gas Processes (J G L–April 25.) 3500 w.

†12578. Test of a One Hundred Horse-Power Gas Engine Using Producer Gas. Ill. H. W. Spangler (J F I–May.) 4000 w.

12618. Advantages of Gas over Coal for Cooking and Heating Purposes. William Wallace Goodwin (A G L J–May 8.) 1700 w.

*12637. Gasfitting (G W–April 29.) 1300 w.

Serials.

11993. Oxid of Iron: A Monograph. John T. Sheard (J G L–Began April 4—4 parts to date—30 cts. each).

11994. Gas Works as Central Stations for the Supply of Light, Heat, and Power. W. von Oechelhaeuser (J G L–Began April 4—Ended April 11—2 parts—30 cts. each).

HYDRAULICS.

*11900. Iron and Steel Water Tanks. Abstract of paper by William C. Coffin, Jr. (I–March 31.) 1000 w.

†11955. Discussion on "The Use of Asphaltum for Reservoir Linings," by James D. Schuyler, R. C. Gemmell, C. B. Brush, S. Whinery, J. F. Flagg, W. B. Parsons, R. L. Harris, Foster Crowell, M. Fargusson, F. Collingwood, E. P. North, and J. F. O'Rourke (T C E–April.) 7000 w.

12029. The New Dam for the Water Works of Sante Fé, N. M. Ill. (E N–April 13.) 500 w.

12090. The Filtration of Water through Sand (E R–April 15.) 2000 w.

12217. The Long Island Water Supply Co. Case (E N–April 20.) 1000 w.

12218. Worthington High-Duty Pumping Engine at Philadelphia, Pa. Ill. (E N–April 20.) 2300 w.

12236. A Suburban Water Works System. Ill. (E R–April 22.) 900 w.

*12278. The Water Supply of Chicago. Editorial (E–April 14.) 1800 w.

†12307. The Use of Bone-Black in Domestic Filters, with Discussion. R. N. Clark (E S W P–Feb.) 5900 w.

†12330. Australian Irrigation. E. D. Millan (A P R–March 15.) 2500 w.

*12349. The Duty of Pumping Engines. John H. Barr (S J E–April.) 2000 w.

12354. Operating the San Antonio, Tex., Water Works by Electric Motor. Ill. (E E N Y–April 26.) 500 w.

12381. Diagrams for Hydraulic Formulas. Ill. A. L. Adams and R. G. Gemmell (E N–April 27.) 1300 w.

12486. Some Large Water Power Stations. Ill. (E W–May 6.) 800 w.

12593. Areas and Capacities of Dams. Ill. (P S–May.) 700 w.

12619 Eight Feet of Mud in a Cincinnati Reservoir (F W–May 6.) 1600 w.

INDUSTRIAL CHEMISTRY.

*12098. Estimation of Arsenic and Phosphorus in Iron Ores, etc. John Pattinson and H. S. Pattinson (I–April 7.) 2400 w.

*12153. Calorimetric Determination of Coal. Ill. (Eng L–April 7.) 2500 w.

Serials.

11049. The Applications of Ozone. Ill. (E R L–Began Feb. 24—Ended March 31—5 parts—30 cts. each).

11891. Water Analysis. H. Van F. Furman and Prof. Tilden (Sc Q–Began March—1 part to date—45 cts).

12475. Applications of Ozone. Appendix (E R L–Began April 21—Ended April 28—2 parts—30 cts. each).

12603. Facts and Figures on Electrolytic Chlorine and Soda. Emile Andreoli (E R L–Began April 28—1 part to date—30 cts).

INDUSTRIAL SOCIOLOGY.

*11852. What Will the Democrats Do? A forecast of tariff legislation. John DeWitt Warner (E Mag–June.) 3000 w.

12041. The Coming Scale Discussion. Editorial (A M & I W–April 14.) 800 w.

12043. Labor in Europe. Participation in Profits and Pensions (B J C–April 15.) 1200 w.

12059. The Law of Strikes.—Decision of Judge Emery Speer (A & B–April 15.) 700 w.

*12085. The Eight Hour Day.—What Does Experience Teach? "Yorkshireman in London" (R R L–April 7.) 1850 w.

*12166. Signalmen and Their Hours. Editorial (A J R A–April.) 900 w.

*12182. Organized Labor and the Law. Edward Arden (Ch–May.) 3200 w.

†12190. The Social Remedies of the Labor Party. W. H. Mallock (F R–April.) 9300 w.

*12255. Strikes and Lock-outs, Old and New (J G L–April 11.) 1900 w.

*12306. The Labor Troubles at Hull (I L–April 14.) 400 w.

12308. Another Railway Employés' Union. Editorial (R A–April 21.) 1000 w.

*12319. The Hull Dock Strike. Editorial (Eng L–April 14) 1600 w.

12320. The Interstate Law vs. the Walking Delegate. Thomas Coram (B C–April 22.) 800 w.

12336. A Campaign of Education. Editorial (R R–April 22.) 700 w.

12339. How Monopolies End (A S–April 22.) 600 w.

12340. Revival of Arbitration. Editorial (A S–April 22.) 600 w.

12341. Some Stoppages of Labor and Their Causes (A S–April 22.) 700 w.

†12369. Recent Labor Rulings by Federal Courts. Aldace F. Walker (F–May.) 4800 w.

†12370. Compulsory Arbitration an Impossible Remedy. Carroll D. Wright (F–May.) 4000 w.

†12371. Menacing Socialism in the Western States. Frank B. Tracy (F–May.) 5200 w.

†12373. How to Introduce the Initiative and Referendum. W. D. McCrackan (A–May.) 2200 w.

12385. Profit Sharing and the Labor Problem. A Workman (A M -April 27.) 700 w.

12392. Demands of Labor Unions (M S P–April 22.) 2000 w.

12411. Federal Intervention in Strikes. Editorial (I T R–April 27.) 600 w.

12416. The Supervision and Regulation of Corporations.—The Way Not to Do It. Allen R. Foote (S R N–April 29.) 2500 w.

*12429. The Threatened Dock and Shipping Strike.—A Review of the Situation (Tr–April 21.) 4400 w.

12434. The Nationalization of a Trade Union. Thomas Coram (B C–April 29.) 700 w.

*12437. The Strike at Hull. Editorial (I L–April 21.) 1200 w.

*12470. An Act of Trade Unionism (B A–April 21.) 1300 w.

†12502. The Ann Arbor Strike. Frank P. Sargent (N A R–May.) 2000 w.

†12505. Is Land Held Out of Use? William B. Cooper (N A R–May.) 850 w.

*12507. How a Socialist Millennium Would Work.—Eugene Richter's Pictures of the Future (R of R–May.) 14000 w.

12523. Convicts and Highways. Editorial (A S–April 29.) 600 w.

12539. Trusts. Philosoph (E N Y–May 3.) 1800 w.

*12634. The Regulation of Ironworkers' Wages in Staffordshire and the North of England (C G–April 28.) 1500 w.

*12639. The American View of Sympathetic Strikes. Editorial (Tr–April 28.) 1700 w.

12642. A Just Distribution of Earnings. Editorial (A M & I W–May 5.) 1000 w.

*12647. The Practicability of the Legal Eight Hour Day. "Yorkshireman in London." (R R L–April 28.) 1400 w.

12657. Fictitions Corporate Capitalization. James A. Logan (R R–May 6.) 3000 w.

12658. The Problem of the Unemployed. Editorial (A S–May 6.) 800 w.

12677. Labor and Law. A. B. Salom (I I G–March.) 1500 w.

Serials.

12282. Labor in Germany (E–Began April 14—2 parts to date—30 cts. each).

LANDSCAPE ENGINEERING.

11958. Some Uses of Formal Gardening (G & F–April 12.) 1000 w.

12506. Landscape Art in Public Parks (G & F–May 3.) 1500 w.

MARINE ENGINEERING.

*11854. The Latest and Greatest Cunarder. Ill. A Clydesider (E Mag–June.) 3000 w.

*11871. The Flensburg Off Shore Floating Dock. Ill. (Eng L–March 31.) 1400 w.

*11922. Discussion of F. Elgar's paper, "The Strength of Bulkheads" (E–March 31.) 2500 w.

*11923. Discussion of paper by George A. Calvert, "The Measurement of Wake Currents" (E–March 31.) 900 w.

*11926. The Atlantic Passenger and Emigrant Trade. Editorial (E–March 31.) 850 w.

*11928. Historic Figure-Heads. Ill. Robert G. Denig (Cos–April.) 3000 w.

*11946. Chapman's Mathematical Propeller. Ill. Gavin Chapman (S L–April.) 1500 w.

*11948. English vs. American Ship Paints (S L–April.) 700 w.

*11949. Types of Mercantile Steamers (S L–April.) 900 w.

12020. The Famous Old Collins Line. Ill. (Sea–April 13.) 900 w.

12021. Why Our Boys Don't Go to Sea. Editorial (Sea–April 13.) 1000 w.

12022. "The American Merchant Service," Its Needs and Abuses. Richard P. Joy (Sea–April 13.) 1500 w.

12057. An Interesting Letter About Foreign Engineers, with Editorial (Eng–April 15.) 1500 w.

12078. Hollow Shafting in Modern Steamships (S V–April 15.) 800 w.

12080. The Ward Boilers Fail on the New Coast-Defense Battle-Ship "Monterey" (S V–April 15.) 900 w.

12081. Will It Beat the Steam Engine? G. Sheffield's Rapid Motor (S V–April 15.) 700 w.

*12115. Shipping Charges and British Industry. Editorial (E–April 7.) 1500 w.

*12116. European Canals. Editorial (E–April 7.) 2000 w.

*12119. On the Measurement of Wake Currents. Ill. G. A. Calvert (E–April 7.) 4000 w.

*12120. The Strength of Bulkheads. F. Elgar (E–April 7.) 3300 w.

*12127. Progress of Shipbuilding in America. Editorial (I L–April 7.) 1000 w.

*12157. The New Harbor of Venice. Editorial (I C T–April 7.) 600 w.

†12178. Growth of Our Knowledge of the Deep Sea. G. W. Littlehales (P S M–May.) 2800 w.

12223. The Harbor of Charleston, S. C. I. W. Avery (M R–April 21.) 800 w.

12226. The Steamboat Inspection Service Considered as It Is by an Expert, Who Says What It Should Be. Howard Patterson (Sea–April 20.) 1200 w.

12227. Conditions and Needs of American Shipping. Thomas W. Hyde and Philip N. Hichborn (Sea–April 20.) 2500 w.

*12276. Boat Railway at Meaux, France. Ill. (E–April 14.) 1100 w.

*12277. The Clyde Passenger Steamer "Isle of Arran." Ill. (E–April 14.) 1600 w.

*12280. Merchant Cruisers. Editorial (E–April 14.) 1000 w.

*12283. The Vibrations of Steamers. Ill. Otto Schlick (E–April 14.) 6000 w.

*12314. The Fastest Paddle Steamer in the World.—Belgian Mail Steamship Leopold II. Ill. (Eng L–April 14.) 2000 w.

*12316. The Draughtometer. Ill. (Eng L–April 14.) 1700 w.

12393. Brief Description of the Ships in the Columbian Naval Celebration. Ill. (Sea–April 27.) 3500 w.

12403. Salvage Services. Editorial (M Rec–April 27.) 1000 w.

*12430. Production, Prices, and Wages in Ship building (Tr–April 21.) 1500 w.

*12439. The Cunard Royal Mail Twin-Screw Steamers "Campania" and "Lucania." Ill. (E–April 21.) 33000 w

*12478. The Propulsion of Ships. Editorial (Eng L–April 21.) 1350 w.

12488. Electric Launches at the World's Columbian Exposition (E R N Y–May 6.) 700 w.

*12526. Boiler Tubes. Ill. (A E R J–May.) 4000 w.

12552. Ice-Harbors in the Delaware River and Bay. Ill. A. Stierle (E N–May 4.) 5300 w.

*12597. United States Atlantic Liners. Editorial (Eng L–April 28.) 1150 w.

*12599. Compound Marine Engines. Editorial (Eng L–April 28.) 1500 w.

Serials.

11127. Resistance to Ship's Motion. A Natural Law Newly Discovered. F. M. F. Cazin (J F I–Began March—Ended May—3 parts—45 cts. each).

11978. Some of My Experiences as an Engineer on the Niger. John Parkin (E G–Began April—1 part to date—30 cts).

12250. Capt. Alexander McDougall's Patents. Since Application for a Patent on the Whaleback Type of Vessel (M R C–Began April 20—2 parts to date—15 cts. each).

MECHANICAL ENGINEERING.

11859. The American Passenger Elevator. Thomas E. Browne, Jr. (E Mag–June.) 3000 w.

*11868. Great Western Manufacturing Company. Ill. (E I–April.) 1200 w.

12008. The Cost and the Value of Compressed Air (A M–April 13.) 600 w.

12009. Foundry Talk. Charles Smith (A M–April 13.) 1300 w.

12084. Practical View of the Case. Over-Production of Machines. C. R. Tompkins (A S–April 15.) 900 w.

*12140. Some Valuable Hints to Inventors. Review of R. Grimshaw's "Tips to Inventors" (Inv–April 8.) 2800 w.

*12313. Roller and Ball Bearings. Ill. (Eng L–April 14.) 3000 w.

12335. Unloading the Large Krupp Gun. Ill. (R R–April 22.) 700 w.

12387. Coe Brass Manufacturing Company. F. J. M. (A M–April 27.) 3000 w.

12394. Charging Machine for Blooming Mills. Ill. (Ir Age–April 27.) 1000 w.

*12559. A Weldless Chain, with Discussion. Ill. Ludwig Herman (J A E S–March.) 4500 w.

12613. Concerning Lubricators. W. H. Wakeman (M G–May 6.) 950 w.

12655. A Powerful Excavator. Ill. (R R–May 6.) 600 w.

12659. Special Machines and Improvements. C. R. Tompkins (A S–May 6.) 1200 w.

Serials.

11569. The Mannesmann Process of Seamless Tube Rolling (M W–Began March 17—4 parts to date—30 cts each).

11904. Engineer's Cutting Tools. Ill. Thomas Foster (P Eng–Began March 31—Ended April 7—2 parts—30 cts. each).

12142. On Machine Designing (M W–Began April 7—2 parts to date—30 cts. each).

METALLURGY.

*11855. Evolutions of the Iron-Founder's Art. Stephen Bolland (E Mag–June.) 3000 w.

11865. A New Grouping for Pig Iron and Other Substances (E M J–April 8.) 900 w.

11866. The Russell Process at Somhrerete, Mexico. Fred M. Watson (E M J–April 8.) 1400 w.

11867. The Development of Some Ontario Ores. T. D. Ledyard (E M J–April 8.) 700 w.

†11888. The Assay of Gold and Silver Ores. H. Van F. Furman (Sc Q–March.) 3700 w.

†11889. Design for Assay Furnace. Ill. James L. Wells (Sc Q–March.) 1000 w.

†11890. The Determinating of Copper by the Iodide Method. G. E. Jewell (Sc Q–March.) 1000 w.

*11927. Alloys: Abstract of 4th Lecture by W. C. Roberts-Ansten (E–March 31.) 2300 w.

*11936. Determination of Phosphorus in Iron and Steel. Adolphe Carnot (C G–March 30.) 1300 w.

11982. Home Steel for the South. Editorial (A S–April 8.) 750 w.

11983. The Waste Heat of Coke Ovens (A S–April 8.) 600 w.

*11997. Gold Amalgamation. The Ideal Amalgamator. C G. Wamford Lock (A M S–Feb. 25.) 1400 w.

12018. The Buffalo Furnace. Ill. (Ir Age–April 13.) 2100 w.

12019. The First Blast Furnace in America. Ill. W. N. Adams (Ir Age–April 13.) 5800 w.

12032. What Shall We Do with Our Rail Mills? (E N–April 13.) 2000 w.

12063. The Construction of Lead Blast Furnaces. Ill. H. O. Hoffman (E M J–April 15.) 2200 w.

*12099. Magnetite in Minerals and Rocks. A. Liversidge (I–April 7.) 1350 w.

*12128. The Tin-Plate Industry of the United States (I L–April 7.) 1000 w.

*12129. The Manufacture of Alumina (I L–April 7.) 1500 w.

*12131. The Limits of Accuracy in Gold Assay (I L–April 7.) 800 w.

*12141. Some Remarks on Steel. Walter J. May (Inv–April 8.) 1100 w.

*12149. Notes on Emmerton's Method for the Determination of Phosphorus. H. C. Babbitt (C G–April 7.) 900 w.

12213. Wainwright's Process for Reducing Low Grade Ores. Ill. (I T R–April 20.) 1100 w.

12220. The Nan Method of Casting Sound Ingots. Ill. (Ir Age–April 20.) 1000 w.

12221. Can Tin Plate Be Too Good? Editorial (Ir Age–April 20.) 700 w.

12265. Standard Methods for Metallurgical Chemists. Editorial (E M J–April 22.) 1500 w.

*12286. Compounding Blowing-Engines. T. Westgarth (I–April 14.) 1700 w.

12405. Segregation in Metals (E M J–April 29.) 1500 w.

*12455. Mild Open-Hearth Steel for Castings, with Discussion. A. B. Winder and J. Dixon Brunton (I–April 21.) 6000 w.

*12456. Hammering vs. Cogging (I–April 21.) 900 w.

*12457. The Utilization of Blast Furnace Slag. R. Zsigmoudy (I–April 21.) 1100 w.

*12464. The Recent Growth of Foreign Mineral Industries (C G–April 21.) 1500 w.

*12465. Sulphur and Phosphorus in Iron (C G–April 21.) 1500 w.

*12476. The Lndhoe Iron and Steel Works, Spennymoor. Ill. (Eng L–April 21.) 5500 w.

12521. Iron and Steel. B. F. Spalding (A S–April 29.) 2500 w.

*12530. A New Method of Smelting and Casting Metals. Ill. (A E R J–May.) 800 w.

*12601. Tensile Tests and Chemical Analyses of Copper Plates from Fire-Boxes of Locomotives on the Great Western Railway. Abstract of Paper by William Dean (I L–April 28.) 1800 w.

*12621. Technical Importance of Aluminum and Its Future Applications. J. Klaudy (I–April 28.) 1900 w.

*12633. Manganesiferous Iron (C G–April 28.) 1300 w.

12641. Objections to By-Product Coke Ovens (A M & I W–May 5.) 1200 w.

*12673. On Copper Smelting in Russia (I & S–April 29.) 2800 w.

Serials.

9459. The Manufacture of Coke. Ill. John Fnlton (C E–Began Jan.—5 parts to date—30 cts. each).

10275. The Analysis of Iron and Steel. J. Parry and J. J. Morgan (I L–Began Jan. 27—4 parts to date—30 cts. each).

10971. Resistance of Metals to Shear. H. V. Loss (A E R J–Began March—3 parts to date—30 cts. each).

11736. The American Tin-Plate Industry (I–Began March 24—2 parts to date—30 cts. each).

11901. Paints for Metallic Structures. John Newman (I–Began March 31—Ended April 7—2 parts—30 cts. each).

11998. Crushing Rolls. F. Danvers Power (A M S–Began Feb. 25—2 parts to date—30 cts. each).

12159. Technical Education for the Molder. S. Bolland (F D–Began April 10—1 part to date—15 cts).

12195. Molding by Machinery — Foundry

Appliances, etc. Ill. S. Bolland (A M–Began April 20—1 part to date—15 cts).

12206. The Sulphid Question—A Proposed System of Treatment (A M S–Began March 18—1 part to date—30 cts).

12267. The Bessemerizing of Copper Matte, and Production of Pig Copper. Ill. Charles Wade Stickney (E M J–Began April 22—Ended May 6—3 parts—15 cts. each).

12406. Variations in the Milling of Gold Ores—Ballarat, Victoria. Ill. T. A. Rickard (E M J–Began April 29—Ended May 6—2 parts—15 cts. each).

12458. The Effects of Alloys on the Mechanical and Physical Properties of Metals. W. C. Roberts-Austen (I–Began April 21—2 parts to date—30 cts. each).

MILITARY ENGINEERING.

*11925. Quick-Firing Guns in the Field. Editorial (E–March 31.) 2300 w.

12005. The First War Steamer of the World. Ill. (Sc A–April 15.) 1200 w.

*12184. The Standing Army of the United States. Guy Howard (Ch–May.) 4400 w.

*12252. The Society of the Cincinnati. Ill. John Bunting (L Mag–May.) 3200 w.

12264. The Wire-Wound Gun.—It Withstands a Pressure That Would Blow Any Other Gun to Atoms (B J C–April 22.) 500 w.

*12318. Umpire's Report on the Naval Manœuvres, 1892. Editorial (Eng L–April 19.) 2200 w.

*12347. The Construction of Guns at the Washington Navy Yard. E. B. Clark (S J E–April.) 2500 w.

*12350. Prison Life at Belle Isle. Ill. Joseph C. Helm (Cos–May.) 5200 w.

†12372. Anomalies of Our Private Pension System. Thomas F. Dennis (F–May.) 4200 w.

12383. The White Magazine Rifle. Ill. (E N–April 27.) 700 w.

12420. Statue of John Ericsson (A & N J–April 29.) 3500 w.

12421. The International Naval Review (A & N J–April 29.) 3800 w.

12435. Smokeless Powder. Editorial (A & N R–April 29.) 650 w.

*12443. Invisible Torpedo Boats (M W–April 21.) 650 w.

*12480. Improvements in Naval Armor. Editorial (Inv–April 22.) 1900 w.

†12495. Military Misconceptions and Absurdities. James Chester (J M S I–May.) 6500 w.

†12496. Some Remarks on Our New Cavalry Drill Regulations. W. H. Smith (J M S I–May.) 6600 w.

†12497. The Military Uses of Photography. A. Williams (J M S I–May.) 6500 w.

†12499. An Historical Sketch of the Evolution of Tactics. Translated from the German by William C. Rawolle (J M S I–May.) 7500 w.

†12504. Further Views of Pension List Revision. Wheelock C. Veazey, Joseph H. O'Neil, and B. A. Enloe (N A R–May.) 5000 w.

*12528. The Ericsson Submarine Gun. Ill. (A E R J–May.) 500 w.

12534. The Naval Parade and Review. Ill. (Sc A–May 6.) 2000 w.

12544. The British Admiralty List of Reserved Merchant Cruisers (Ir Age–May 4.) 1000 w.

12549. The Katahdin.—American Coast Defense Ram. Ill. (Sea–May 4.) 3000 w.

12590. Naval Land Parade—April 28 (A & N J–May 6.) 3500 w.

12591. Report on Trials of the Wire-Gun (A & N J–May 6.) 1200 w.

12678. Wonderful Armor Plate (I I G–March.) 1200 w.

Serials.

9347. Notes of Lectures on Artillery in Coast Defense. A. C. Hansard (J M S I–Began Jan.—3 parts to date—45 cts. each).

10738. The Development of American Armor Plate. Ill. F. Lynwood Garrison (M–Began Feb. 15—3 parts to date—30 cts. each).

12427. The Construction and Uses of Projectors. F. Nerz (El–Began April 21—Ended April 28—2 parts—30 cts. each).

MINING.

†11892. The Geological Training of a Prospector. Ill. A. Lakes (Sc Q–March.) 3300 w.

†11893. Notes on Mine Surveying. C. M. Eye (Sc Q–March.) 3000 w.

†11894. A New Era in Mining Machinery. Ill. M. C. Ihlseng (Sc Q–March.) 2000 w.

*11914. The Estimation of the Actual Effective Pressure or Water Gauge in the Ventilation of Mines. T. A. Southern (I C T–March 31.) 3000 w.

*11929. The Great Florida Phosphate Boom. Ill. A. Allen (Cos–April.) 4000 w.

*11930. Some Biographical Sketches of Miners, Metallurgists, and Allied Workers. Ill. (Inv–March 25.) 11500 w.

*11931. Electrical Shot Firing. Ill. (Inv–March 25.) 1800 w.

*11932. Roburite and High Explosives. Editorial (Inv–March 25.) 800 w.

*11935. Working Electric Signals from the Electric Light Service in Mines. Sydney F. Walker (C G–March 30.) 1700 w.

*11937. The Determination of Firedamp by the Limits of Inflammability. M. H. Le Chatelier (C G–March 30.) 1800 w.

11979. Present Condition and Future of Mining. Editorial (M I T–April 6.) 1500 w.

12037. The Gold Field of Virginia (M R–April 14.) 600 w.

12062. The Monte Cristo Mining District, Washington. Ill. R. H. Stretch (E M J–April 15.) 900 w.

12083. Electricity in Mining Indnstries. Editorial (A S–April 15.) 600 w.

*12168. Coal (A J R A–April.) 850 w.

12173. The Coals of Colorado (M I T–April 13.) 2500 w.

12193. The Yukon River Region (M S P–April 15.) 1800 w.

12194. The Kootenai Country (M S P–April 15.) 1350 w.

*12201. The Mount Lyell Copper Mine—An Extraordinary Deposit. Dr. Peters (A M S–March 4.) 1500 w.

*12203. Tin Saving. Phœnix (A M S–March 11.) 1600 w.

*12204. Mining near Yea (Vic.) (A M S–March 11.) 1000 w.

12251. Coal of the World (M G–April 22.) 2200 w.

12263. Chalk Beds of Texas—The Greatest Chalk Region in the World (B J C–April 22.) 1500 w.

12266. The Reynoldsville, Pa., Coal Field and a Novel Drainage System. Ill. Frank M. Brown (E M J–April 22.) 1700 w.

*12279. The Mining Royalties Commission. Editorial (E–April 14.) 3200 w.

*12281. The Production of Minerals in the United Kingdom in 1892 (E–April 14.) 1200 w.

*12305. Mineral Royalties and Manufacturing Industry. Editorial (I L–April 14) 1250 w.

*12327. Bas-Boulonnais Coal Measures. Ill. Ludovic Breton (C G–April 14.) 3000 w.

*12328. The Useful Effect of a Rateau Fan. A. Macquet (C G–April 14.) 4800 w.

*12329. Extraordinary Outbursts of Soft Coal and Gas. Joseph Dickinson (C G–April 14.) 3300 w.

12334. Machinery and Mining. Editorial (M S R–April 20.) 900 w.

12343. Loss of Life in Mine Explosions. Editorial (M I T–April 20.) 550 w.

12344. The Gold Mines of India (M I T–April 20.) 800 w.

12391. Progress of Mining in New Zealand (M S P–April 22.) 2500 w.

12408. Waste in Mining and Preparing Anthracite Coal (E M J–April 29.) 800 w.

12436. The First Petroleum Company (O P D R–May 1.) 1300 w.

*12444. The Economic Geology of Mercury. Ill. H. A. Wheeler (C E–May.) 1800 w.

*12447. Pump Valves.—The Various Types in Common Use. Ill. Dugald Baird (C E–May.) 3500 w.

*12448. A History of Coal Mining. Fred. C. Keighley (C E–May.) 4000 w.

*12451. Conditions to Be Taken into Consideration in Opening Up a Mine. M. C. Ihlseng (C E–May.) 1200 w.

*12466. A New Process of Blasting by Explosives : A Contribution to the Solution of the Fire-Damp and Coal Dust Problems. F. Pfieffer (C G–April 21.) 2000 w.

*12467. Prevention of Overwinding. M. V. Triprier (C G–April 21.) 2000 w.

*12468 Commnnication between Cage and Bank. M. Janet (C G–April 21.) 1600 w.

*12479. Gold Mining in India. Editorial (Eng L–April 21.) 1100 w.

12515. Electric Haulage in the Rock Springs Coal Mines, Wyoming. Ill. (E E N Y–May 3.) 500 w.

12524. Science in Mining. Editorial (M I T–April 27.) 1000 w.

12525. Two Mining Accidents (M S R–April 27.) 1600 w.

*12606 Depression in the Mining and Metallurgical Indnstries (E–April 28.) 800 w.

*12629. Mine Blasting with Maximum Effect and Minimum Danger. J. W. P. (C G–April 28.) 2500 w.

*12631. Non-Inflammability of Firedamp through the Miner's Pick (C G–April 28.) 1200 w.

*12632. Lateral Influence of Subsidence in Mines. M. H. Villot (C G–April 28.) 1400 w.

*12638. The Park Slip Colliery Explosion (I C T–April 28.) 650 w.

12679. The Cause of Ore Chutes. A. F Wuensch (M I T–May 4.) 1000 w.

12681. Economic Geology of North Carolina. Ill. J. A. Holmes (S S–May.) 4500 w.

Serials.

9003. Diamonds in India : A Rechauffée. W. King (I E–Began Nov. 19—5 parts to date—45 cts. each).

10645. Croydon. (N. Q) Jno. Harvey (A M S–Began Jan. 14—4 parts to date—30 cts. each).

11282. Mine Ventilation Made Easy. W. Fairley (C E–Began March—3 parts to date—30 cts. each).

11385. Selecting and Calculating a Fan, with Tests of Ratean Fans (C G–Began March 10—3 parts to date—30 cts. each).

11574. The Mineral Resources of the Southern States (I L–Began March 17—2 parts to date—30 cts. each).

11801. Information to Aid in the Search for Gold and Silver. Ill. Arthur C. Lakes (C E–Began April—2 parts to date—30 cts. each).

11804. Fire-Damp. H. LeChatelier. Translated by H. H. Stock (C E–Began April—2 parts to date—30 cts. each).

11820. From Mine to Furnace. John Birkinbine (J F I–Began April—Ended May—2 parts—45 cts. each).

11945. Three River Bog Iron Ores. A. P. Lowe (I & S–Began April 1—Ended April 8—2 parts—30 cts each).

12205. Tin Deposits, Brookstead Estate, Tasmania (A M S–Began March 18—1 part to date—30 cts).

12222. The Iron Ores of North Carolina (M R–Began April 21—2 parts to date—15 cts. each).

12402. The State Chemist's Report on Florida Phosphates (M R–Began April 28—2 parts to date—15 cts. each).

12450. The Coal Fields of Canada. William Hamilton Merritt (C E–Began May—1 part to date—30 cts).

RAILROADING.

*11856. The Trans-Siberian Railway. Frederick Hobart (E Mag-June.) 3000.

11862. The Development of Fixed Signals on Railroads. Ill. Arthur H. Johnson (R G-April 7.) 3800 w.

11902. Railway Progress and Railway Poverty. Ossian D. Ashley (R A-April 7.) 2200 w.

11903. "Pennsylvania Tours to the Golden Gate." Ill. (R A-April 7.) 1400 w.

11905. The Advantage of Smaller Engines for Fast Passenger Service. Editorial (R M M-April.) 1400 w.

11906. The Care of Foundation Brakes. Ill. E. J. with Editorial (R M M-April.) 2200 w.

11907. Reinforcing Brake Apparatus. Ill. (R M M-April.) 1500 w.

11917. Railroads, Men and Laws. Frederick E. Goodrich (B C-April 8.) 1000 w.

11950. Painting of Passenger Cars. Ill. Duane Doty (R C J-April.) 1500 w.

11951. Contagion in Passenger Cars (R C J-April.) 500 w.

†11957. Street Motors on the Government Tramways at Sydney, New South Wales. George Downe (T C E-Feb.) 1000 w.

*11963. Curve Resistances (R P L-April 1.) 1900 w.

*11964. Sunday Work on German Railways (R P L-April 1.) 700 w.

*11965. The South African "Pullman Car." Ernest J. Price (R P L-April 1.) 1800 w.

11974. Railroad Management, Past, Present, and Prospective. Quintin McNab (R R-April 8.) 2000 w.

11975. The Auditing of Express Accounts. Editorial (R R-April 8.) 1150 w.

11976. The Ann Arbor Cases.—Judge Rick's Decision (R R-April 8.) 4000 w.

11991. Electric Railroads and Electrolysis. Editorial (E E N Y-April 12.) 1000 w.

12013. The Boynton Electrical Bicycle Road. Ill. (E W-April 15) 1600 w.

12028. Four-Track Steel Viaduct; New York Central and Hudson River R. R. (E N-April 13.) 1900 w.

12031. English and American Train Loads (E N-April 13.) 2500 w.

12036. The Hamilton and Barton Incline Railway (E N-April 13.) 1500 w.

12040. Underground Rapid Transit Proposed for New York (W E-April 15.) 1000 w.

12047. The Block Signals in the Fourth Avenue Tunnel (R G-April 14.) 2000 w.

12048. Some of the Questions before Railroad Managers. H. S. Haines (R G-April 14.) 1900 w.

12049. Railroad Matters in Colombia. S. B. M'Connico (R G-April 14) 1500 w.

12050. The Recent Injunction Cases. Editorial (R G-April 14.) 1250 w.

12051. Railroad Mortgages and Earnings. Editorial (R G-April 14.) 900 w.

12052. An Episode in New York Rapid Transit (R G-April 14.) 700 w.

12056. Buying for a Railroad (M G-April 15.) 500 w.

12073. The Commercial and Political Considerations Involved in Sympathetic Railroad Strikes. Joseph Nimmo, Jr. (R R-April 15.) 2500 w.

12074. The Automatic Vacuum Brake as Used in England. Ill. (R R-April 15.) 1000 w.

12075. Recent Improvements in Block Signals. C. H. Platt (R R-April 15.) 3000 w.

12076. Judge Taft's Decision (R R-April 15.) 4500 w.

12077. A Terrible Locomotive Boiler Explosion.—Near Butte, Montana. Ill. (S V-April 15.) 1600 w.

12111. The Federal Control of Railways. S. M. Cullom (R A-April 14.) 2800 w.

12112. Amendment of Line on Northern Pacific Railroad.—The Granite Viaduct, with Editorial. Ill. J. W. Kendrick (R A-April 14.) 4200 w.

*12133. Speed Registering Attachment for Locomotives (P Eng-April 7.) 700 w.

*12165. The Lake Shore and Michigan Southern Railway. Ill. C. P. Leland (A J R A-April.) 3800 w.

12171. Street Car Building. L. M. Delamater (S R G-April 15.) 700 w.

12172. Electric Rapid Transit Projects Abroad. C. J. Black (S R G-April 15.) 1450 w.

12200. The Broadway Cable Railway, New York. Ill. (Sc A-April 22.) 1000 w.

12219. A Plan Adopted for Rapid Transit in New York City (S R N-April 22.) 1200 w.

12224. Railroad Development in West Virginia (M R-April 21.) 900 w.

12238. Letter from A. M. Waitt in reply to criticism of his paper, "The M. C. B. Type of Coupler" (R G-April 21.) 2000 w.

12239. Local Transportation to the World's Fair. Ill. (R G-April 21.) 4300 w.

12240. The "John Bull" Train on the Pennsylvania. Ill. (R G-April 21.) 1100 w.

12241. Continuous Car Heating in Winter. Discussion at New England Railroad Club, April 12 (R G-April 21.) 2700 w.

12242. A Mistake in Elevated Railroad Extension (R G-April 21.) 700 w.

12244. An Official Utterance on Signalling (R G-April 21.) 2500 w.

12245. An Accident on a Chicago Cable Road (R G-April 21.) 700 w.

*12300. A Railroad Advertising Bureau.—Something About Time-Tables. George C. Johnson (R'y N-March.) 1100 w.

*12301. Central Buys the Northern.—Vanderbilts Have a Monopoly of All Railroads Entering New York from the North (R'y N-March.) 600 w.

12309. The Federal Control of Railways.—A Reply to S. M. Cullom. George R. Blanchard (R A-April 21.) 4500 w.

12310. The Staying of Crown Sheets. W. F. Dixon (R A–April 21.) 1000 w.

*12317. Railways in European Turkey. Map (Eng L–April 14.) 1000 w.

†12323. Improved Railway Communication for Calcutta. George E. Moore (I E–March 25.) 500 w.

12331. Street Railway Law in Connecticut S R G–April 22.) 350 w.

12332. Signal Tower of the Chicago City Railway. Ill. (S R G–April 22.) 900 w.

12333. The Electric Railway in Bangkok (S R G–April 22.) 1000 w.

12337. Line Claims and Their Treatment. Editorial (R R–April 22.) 1500 w.

12338. Reasonable Rates.—Report of Committee of the Railroad Commissioners of the United States (R R–April 22.) 3800 w.

12360. Storage Battery Cars on Second Avenue (E R N Y–April 29.) 500 w.

12366. Safety Fuses vs. Magnetic Cut Outs in Electric Railway Work. W. E. Harrington (E W–April 29.) 1000 w.

†12374. Railway Tariffs. James L. Cowles (A–May.) 2700 w.

12379. The Duggan Switch. Ill. (E N–April 27.) 600 w.

12396. Publicity of Accounts as a Means of Controlling Railroads. Henry C. Adams (R G–April 28.) 2000 w.

12398. The Economy of Small Freight Cars. Editorial (R G–April 28.) 1000 w.

12399. The South Street Collision. Editorial (R G–April 28.) 1400 w.

12417. The Inventor of the Sleeping Car (Eng–April 29.) 600 w.

12459. The Claim Agent. L. L. Gilbert (R A–April 28.) 3600 w.

12460. Railway Car Construction. John Kirby (R A–April 28.) 1000 w.

*12474. Tramways vs. Telephones. S. Sellon (E E L–April 21.) 2600 w.

12483. The Intra-Mural Railway at the World's Fair. Ill. (E W–May 6.) 5000 w.

*12490. Laying Out Shoes and Wedges. G. K. W. (L E–May.) 1000 w.

†12491. Studies in Track and Roadway Construction. Ill. (S R J–May) 1600 w.

†12492. Portland, Ore. Ill. (S R J–May.) 12000 w.

†12493. Tacoma, Wash. Ill. (S R J–May.) 3500 w.

†12494. Seattle, Wash. Ill. (S R J–May.) 7800 w.

†12501. A Railway Party in Politics. Harry P. Robinson (N A R–May.) 3000 w.

12516. Early Locomotives on the London and Northwestern Railway. Ill. (R R–April 29.) 300 w.

12517. M. C. B. Coupler Tests. Editorial (R R–April 29.) 1800 w.

12518. Thirty-ninth Annual Report of the Chicago, Burlington and Quincy R. R. (R R–April 29.) 1500 w.

12520. How Grade Crossings May Be Abolished in Chicago. Harvey E. Park (R R–April 29) 1400 w.

12522. Regulation of Electric Railroads. Editorial (A S–April 29.) 700 w.

*12529. Crossings of Great Rivers.—A Contribution to Railroad Location. Appendix. Ill. A. Zdziarski (A E R J–May.) 1800 w.

12550. Railway Improvements for the World's Columbian Exposition Traffic (E N–May 4.) 1200 w.

12553. A Natural Railway Tunnel. Ill. Emile Low (E N–May 4.) 1500 w.

12556. American, English, and Indian Railways.—Railways (E N–May 4.) 4000 w.

*12557. Notes on English Railways. E. R. Turner (J A E S–March.) 7500 w.

12566. Equipment of Electric Cars. E. C. Westcott and E. Craig (C E N–May.) 2000 w.

12570. A Chapter of Recent English Railroad History. W. M. Acworth (R G–May 5.) 2000 w.

12571. The New York and Chicago 20-Hour Train. Editorial (R G–May 5.) 900 w.

12572. Russian Railroads (R G–May 5.) 900 w.

12587. Standard Suburban Coach — Illinois Central Railroad. Ill. (R C J–May.) 1000 w.

12588. The Importance of Varnish in the Maintenance of Passenger Equipment. Charles E. Copp (R C J–May.) 800 w.

12589. The Varieties of Woods Used in the Construction of Freight and Passenger Cars, at Pullman, Ill. D. Doty (R C J–May.) 1800 w.

*12596. Winby's Express Locomotive. Ill. (Eng L–April 28.) 1100 w.

*12598. Railway Accidents. Editorial (Eng L–April 28.) 1500 w.

*12600. The Pool and Hamworthy Junction Railway. Ill. (I L–April 28.) 1600 w.

†12624. Madras Railway Company (I E–April 1.) 1200 w.

*12635. Coal Production and Railway Demands in India (C G–April 28.) 1600 w.

*12643. The Great Eastern Railway and the Stratford Works. Ill. (R W–April.) 8500 w.

*12644. The Railway Commissioners of New South Wales on English Locomotives. Ill. (R W–April.) 1300 w.

*12645. The Cleaning of Tramway and Other Rails. H. Couradi (R W–April.) 3600 w.

*12646. Fines on Railways. Editorial (R R L–April 28.) 1000 w.

12648. An Old Fashioned Rate War. Editorial (R A–May 5.) 600 w.

12649. Some Practical Talk to Track Men. E. P. Hawkins (R A–May 5.) 1200 w.

12652. Why Railway Rates Are Based on Distance in Local Traffic. Jas. L. Cowles (R R–May 6.) 1800 w.

12653. Signals and How They Should Be Handled. Signal (R R–May 6.) 900 w.

12656. A Question of Classification. Editorial (R R–May 6.) 1000 w.

12661. Rapid Transit in Boston. Editorial (E R–May 6.) 1550 w.

12672. The Electrical Illumination of Steam Railroad Cars (E W–May 13) 700 w.

Serials.

7456. The Locomotive Boiler. Ill. Gustav Richard (A J R A–Began Oct.—Ended April—6 parts—30 cts. each).

9254. Railway Management. Horace Cope (R R–Began Dec. 31—5 parts to date—15 cts. each).

9689. Railroad Car Design. Ill. Archer Richards (R C J–Began Jan.—3 parts to date—15 cts. each).

10502. English and American Railways. Ill. William M. Acworth (E Mag–Began April—3 parts to date—30 cts. each).

11896. The Madras Electric Tramway Company (I E–Began March 4—2 parts to date—45 cts. each).

11897. Proposed Calcutta Tunnel. Ill. William Duff Bruce and J. H. Greathead (I E–Began March 4—2 parts to date—45 cts. each).

11921. Earth Slips and Subsidences. Ill. Henry E. P. Cottrell (E–Began March 31—Ended April 7—2 parts—30 cts. each).

11962. The History of the South-eastern Railway. G. A. Sekon (R P L–Began April 1—1 part to date—30 cts).

12001. Rails on the Creep. A. Ewbank (I E–Began March 11—3 parts to date—45 cts. each).

12177. The First Electric Railway in New Orleans. Ill. A. Langstaff Johnston (E E N Y–Began April 19—2 parts to date—15 cts. each).

12527. Patenall's Improved Sykes' System of Block Signals (A E R J–Began May—1 part to date—30 cts).

12614. Railway-Stations. Ill. Léon Benonville (A A–Began May 6—1 part to date—15 cts).

SANITARY ENGINEERING.

11941. Dry Closets at the Pencoyd Iron Works. Ill. (E R–April 8.) 500 w.

†11953. Discussion on "The Storm Hydro-Pneumatic System of Sewerage." F. P. Stearns, J. J. R. Croes, J. Foster Flagg, William L. Saunders, William Barclay Parsons, A. Fteley, F. W. Skinner, Rudolph Hering, and U. H. Broughton (T C E–Feb.) 9000 w.

*12096. Plumbing. John Honeyman (A L–April 7.) 5500 w.

12154. Plumbers Should Influence Sanitary Legislation. W. A. Kelly (D E–April 15.) 1000 w.

12155. Drain and Soil Pipe Ventilation. H. R. Kenwood (D E–April 15.) 3000 w.

12156. Sanitary Drainage and Ventilation. Charles Phelps (D E–April 15.) 1200 w.

*12183. Sanitary Science and the Coming Cholera. C. R. Hammerton (Ch–May.) 2500 w.

12228. Determining Grade of House Drain and Sewer (Met W–April 22.) 500 w.

†12247. The Drainage of Dacca. Editorial (I E–March 18.) 700 w.

†12322. Sanitation in Burma (I E–March 25.) 1200 w.

12342. The Ventilation and Heating of Schools. F. P. Smith (A Ar–April 22.) 2000 w.

*12352. Sanitary Administration of New York City. Cyrus Edson (A H–May.) 3000 w.

*12353. Relation of Sanitation to Municipal Government in Wisconsin. U. O. B. Wingate (A H–May.) 3000 w.

†12368. Municipal Sanitation: Defects in American Cities. J. S. Billings (F–May.) 2600 w.

12390. Use of Marine Salt for the Removal of Snow—Electrolytic Processes of Disinfection (Sc A S–April 29.) 900 w.

·12463. How to Design a Sewerage System. Abstract of Lecture by Rudolph Hering (E R–April 29) 2600 w.

*12513. The Sewerage System of Memphis. George E. Waring, Jr. (P–May.) 3500 w.

*12584. The Sanitation of Country Mansions. Edward Tidman (N W–April.) 1200 w.

12663. Outlet Sewers in New York. Ill. (E R–May 6.) 800 w.

Serials.

8127. Ventilation and Heating. Ill. J. S. Billings (E R–Began Nov. 19—7 parts to date—15 cts. each).

10425. A Healthy Home. F. Vacher (S R–Began Feb. 1—6 parts to date—30 cts. each).

10942. New York Plumbing Regulations. A. H. Napier (E R–Began March 4—4 parts to date—15 cts each).

11166. Mr. Doig's Report on the Shone System at Rangoon (I E–Began Feb. 4—3 parts to date—45 cts. each).

11376. Plumbing in the New Netherlands' Hotel (E R–Began March 18—2 parts to date—15 cts. each).

11687. The Moral, Mental, and Physical Necessities of Ventilation. P. C. Remondino (N P R–Began April—Ended May—2 parts—30 cts. each).

11870. Heating and Ventilating School Houses by the Blower System. Walter B. Snow (Met W–Began April 8—2 parts to date—15 cts. each).

12248. Dacca Municipality. Ill. Report of the Drainage Engineer. J. D. M. Beglar (I E–Began March 18—Ended March 25—2 parts—45 cts. each).

12628. Heating and Ventilation of Residences. James R. Willett (I A–Began April—1 part to date—45 cts).

STEAM ENGINEERING.

*11872. Some Experiments on the Transmission of Heat Through Tube Plates. Ill. A. J. Durston (Eng L–March 31.) 5000 w.

11875. Boiler Capacity. W. H. Wakeman (M G–April 8.) 1000 w.

*11879. Observations on the Working of an Evaporative Condenser. Ill. Michael Longridge (I L–March 31.) 2000 w.

*11911. Economy of a Non-Condensing Compound Engine (E R L–March 31.) 2100 w.

*11933. Engine Fuel: An Experiment. Walter J. May (C G–March 30.) 1000 w.

*11969. McLaren's Smoke Burner. Editorial (Inv–April 1.) 600 w.

11973. Boiler Feed Pumps (S E–April 1.) 2000 w.

*11977. Breakdown of Refrigerating Machinery. Manx (E G–April.) 2700 w.

*11980. The Steam Engine. Review of work by D. K. Clark (A L–March 31.) 2000 w.

12004. The Steam Man. Ill. (Sc A–April 15.) 600 w.

12045. Distribution of Heat and Boiler Settings. Paris, Texas (B J C–April 15.) 1800 w.

12046. About Open Heaters, Lower Manholes, and Curved Bridge Walls (B J C–April 15.) 900 w.

12055. High Steam Pressure (M G–April 15.) 700 w.

†12068. Discussion of paper by Charles E. Emery on "The Cost of Steam Power Produced with Engines of Different Types nnder Practical Conditions" (T A I E E–April.) 7500 w.

12092. Oil in the Boilers, Its Effect and Means of Remedy (E R–April 15.) 900 w.

*12100. The Darby Steam-Digger (I–April 7.) 1000 w.

*12104. Evaporative or Air Condensers for Steam Engines. Editorial (El–April 7.) 1100 w.

*12117. On the Use of Superheated Steam in Steam Engines. Bryan Donkin, Jr. (E–April 7.) 2000 w.

*12118. Harmonic Valve Diagram. Ill. W. E. Dalby (E–April 7.) 2700 w.

*12144. Slide-rule Illustrations (M W–April 7.) 1000 w.

12169. Latent Heat. A. D. Bartlett (A M M–April.) 700 w.

12192. Oil Engines for Small Powers (M N –April 15.) 700 w.

*12296. Steam Engine Trials. P. W. Willans (El–April 14.) 750 w.

*12298. The Coating of Cylinder Walls. A Bandsept (El–April 14.) 800 w.

*12346. The Design of Corliss Valve Gearing. Ill. A. H. Eldredge (S J E–April.) 1200 w.

12384. Behavior of Liquids at High Temperatures. J. Torrey (A M–April 27.) 2000 w.

12395. Basis of Duty Rating of Steam Motors (Ir Age–April 27.) 1750 w.

12412. Superheated Steam. Its Value in a Steam Engine Considered (B J C–April 29.) 800 w.

*12442. Scale in Steam Boilers (M W–April 21.) 1500 w.

*12454. Piston Rod Packings. B. W. Goodsell (N C B–May.) 900 w.

12462. Boiler Trials. W. H. Wakeman (M G–April 29.) 900 w.

*12471. Practical Notes on the Steam Jacket. Ill. W. Fletchei (P Eng–April 21) 2200 w.

12481. Exhaust Steam Induction Condensers. Ill. E. T. Ackerman (S E–April 22.) 2200 w.

12545. Losses In Transmission of Heat. R. C. Carpenter (Ir Age–May 4.) 2000 w.

†12577. Duty Trial of a Pumping Engine, Built by the George F. Blake Manufacturing Company. F. W. Dean (J F I–May.) 3800 w.

12592. Proper Area of Supply Pipes for Engines (P S–May.) 1600 w.

12612. The Duty of Pumping Engines (B J C–May 6.) 1600 w.

12680. The Progress ol Steam Navigation. W. N. Brown (M N–May 1.) 1000 w.

Serials.

11102. Progress in Steam Engineering. Robert H. Thurston (E Mag–Began May—2 parts to date—30 cts each).

11138. Notes on the Steam Injector. Ill. Strickland L. Kneass (E M–Began March—2 parts to date—30 cts. each).

11180. The Expansion of Water by Heat. G. W. Buckwell (S L–Began March—Ended April—2 parts—30 cts. each).

11720. Steam Boilers (T–Began April 1—3 parts to date—15 cts each).

12377. Steam Shovels and Steam Shovel Work. Ill. E. N. Herrmann (E N–Began April 27—2 parts to date—15 cts. each).

TELEPHONY AND TELEGRAPHY.

11878. Progress in Fire Alarm Telegraphy. J. W. Stover (F W–April 8.) 3000 w.

*11909. The Telephone in Vienna. J. Hopkinson (E R L–March 31.) 1200 w.

†11952. Imperial Telegraph System — Cabling to India and Australia. J. Henniker Heaton (C R–April.) 4800 w.

*11967. Telephony in England. Editorial (E L–March 31.) 1300 w.

11986. A Novel Telephone Line Construction (E R N Y–April 15.) 350 w.

*12273. State Telephone to Ireland (E E L–April 14.) 600 w.

*12351. The Telautograph and Its Inventor. Editorial. And a Revolution in Means of Communication. Ill. Elisha Gray (Cos–May.) 800 w.

12487. A Chapter in Submarine Telephony. Ill. (E W–May 6.) 350 w.

12519. A New Printing Telegraph-Machine. Ill. (R R–April 29.) 700 w.

12567. Automatic Telephones. Editorial (C E N–May.) 950 w.

12665. The Use of Accumulators in Telephony. Ill. (E R N Y–May 13.) 700 w.

MISCELLANEOUS.

*11853. Great Britain at the World's Fair. James Dredge (E Mag–June.) 3000 w.

11873. Southern Manufactnring and the Negro (B J C–April 8.) 1100 w.

11877. Accidental Discoveries (M G–April 8.) 2200 w.

*11880. The Settlement of the Cotton Trade Dispute. Editorial (I L–March 31.) 1200 w.

*11899. The Manufacture of Non-Poisonous White Lead, with Discussion. Perry F. Nursey (I–March 31.) 8000 w.

*11919. The Need for a Technical Index (J G L–March 28.) 2000 w.

*11924. The American Inventor. Editorial (E–March 31.) 3100 w.

11938. New York Fire Protection and Street Cleaning. Editorial (E R–April 8.) 700 w.

*11970. The Reign of the Horse. H. N. Hutchinson (Inv–April 1.) 2400 w.

12006. Burned Clay. L. J. Howard (Sc A S–April 15.) 2400 w.

12038. Cotton Mills in the South. D. A. Tompkins (M R–April 14.) 1000 w.

12039. Cottonseed Oil and Rubber. Editorial (M R–April 14.) 700 w.

12042. Crude Oil for all Kinds of Kilns. Thomas Trainor (A M & I W–April 14.) 500 w.

12053. The Ethics of Engineering. D. Fitzgerald and A. W. Locke (R G–April 14.) 2500 w.

12054. Fire Departments in Ancient Rome. Eugene F. Ware (F W–April 15.) 2800 w.

12079. A Bogus Coal-Saver Proves to Be Pure Salt (S V–April 15.) 1800 w.

12089. Specifications. Theodore Cooper (E R–April 15.) 5400 w.

†12145. The Peruvian Corporation and Rubber. J. Orton Kerbey (I R W–April 15.) 1600 w.

†12146. Rubber-Tree Culture in Mexico. The Mexican Minister (I R W–April 15.) 5000 w.

†12147. The Tire Industry. Ill. Sterling Elliott (I R W–April 15.) 1650 w.

12163. The Timber Supply of the United States—An Erroneous Idea of Forest Denudation Exploded by Official Statistics (T–April 15.) 2000 w.

12164. Our Vacant Public Lands. F. H. Newell (Sc–April 14.) 1150 w.

†12179. How Science Is Helping the Farmer. Charles S. Plumb (P S M–May.) 4900 w.

*12180. In and About Modern Athens. Ill. William E. Waters (Ch–May.) 1600 w.

*12181. Chicago and the World's Fair. James P. Holland (Ch–May.) 2700 w.

†12191. What Hinders Emigration to Australasia? M. (W R–April.) 5200 w.

12216. Painting of Wood and Iron Structures. E. H. Brown (E N–April 20.) 3000 w.

12225. A Plan for Stimulating Southern Immigration. Editorial (M R–April 21.) 1200 w.

12234. Aerial Navigation. Editorial (E R–April 22.) 1200 w.

12237. Hot-Water Heating of a Suburban Residence. Ill. (E R–April 22.) 500 w.

12246. The Ethics of Engineering. John W. Ellis, William E. M'Clintock, and Albert F. Noyes (R G–April 21.) 2200 w.

*12253. New St. Louis. Ill. James Cox (L Mag–May.) 5500 w.

12285. Some Notes on Lighthouse Apparatus. J. Kenward (Sc–April 21.) 2300 w.

*12321. The Prospects of Mechanical Flight. Editorial (Inv–April 15.) 2600 w.

†12324. The Kutubdia Lighthouse. Ill. J. H. Toogood (I E–March 25.) 2000 w.

*12345. Ethics for Engineers (S J E–April.) 5000 w.

12359. Triumphs Yet Ahead. John J. Ingalls (E R N Y–April 29) 500 w.

12375. "Maximite," a New Explosive (E N–April 27.) 600 w.

12386. Air Hoists. Frank Richards (A M–April 27.) 12000 w.

12389 Available Force. G. Emil Hesse (E A–April 29.) 900 w.

12397. The Ethics of Engineering. M. M. Tidd and Henry Manley (R G–April 28.) 1300 w.

12400. A Water Tower in Armour's. Ill. T. R. Tinsley (F W–April 29.) 400 w.

*12440. The World's Columbian Exposition, 1893. Ill. (E–April 21.) 84000 w.

12461. Making Silk from Wood (M G–April 29.) 1000 w.

*12489. Heat and Combustion. Angus Sinclair (L E–May.) 1500 w.

†12500. Thoughts Suggested by Prof. Dewar's Discoveries. R. Ogden Doremus (N A R–May.) 3000 w.

†12503. The Hawaiian Situation. Theophilus Harris Davies (N A R–May.) 2000 w.

*12605. County Councils and Technical Education. Editorial (E–April 28.) 2500 w.

*12636. Some Problems of Municipal Engineering. C. D. Marx (I S F–May.) 6000 w.

12660. Overworked Foremen. Harry S. Williams (A S–May 6.) 1500 w.

12682. Social and Industrial Conditions of Arkansas. W. M. Finback (S S–May.) 1500 w.

Serials.

9401. World's Columbian Exposition. Ill. (E N–Began Jan. 5—9 parts to date—15 cts. each).

9745. American Industries and British Commerce (E–Began Jan. 6—13 parts to date—30 cts. each).

10535. Notes from the Engineering Schools (E N–Began Feb. 16—6 parts to date—15 cts. each).

11346. Historical Notes upon Early American Engineers and Their Work. Hale G. Robinson (Eng–Began March 18—4 parts to date—15 cts. each).

11678. Hot-Air Heating. Ill. (Met W–Began April 1—Ended April 8—2 parts—15 cts. each).

12382. The Ideal Engineering School (E N–Began April 27—2 parts to date—15 cts. each).

12477. Argentine (Eng L–Began April 1—2 1 part to date—30 cts).

12540. Early Engineering Reminiscences. George Escol Sellers (A M–Began May 4—1 part to date—15 cts).

NEW BOOKS OF THE MONTH.

[For the convenience of readers any American books will be supplied at publishers' prices by The Engineering Magazine Co. Foreign books, 25 per cent. extra.]

Alexander, P. = Treatise on Thermodynamics. New York: Longmans, Green & Co. [8vo, cloth, 215 p., $1.50.]

Barr, W. M. = Pumping Machinery. A practical hand-book relating to the construction and management of steam power pumping machines. Philadelphia: Lippincott. [8vo, cloth, 447 p., $5.]

Benjamin, Park. = The Voltaic Cell. New York: Wiley. [8vo, cloth, 466 p., $5.]

Billings, J. S. = Ventilation and Heating. New York: The Engineering Record. [8vo, cloth, 500 p., $6.]

Bodley, C. E. = Pocket Reference Book for Tinsmiths and Sheet Metal Workers. Chicago: American Artisan Press. [63 p., paper.]

Brainard, F. R. = Knots, Splices, Hitches, Bends, and Lashings. New York: Practical Publishing Co. [16mo, 76 p., cloth, $1.]

Buckley, Robert Burton. = Irrigation Works in India and Egypt. A reference book with 100 folding plates and maps. New York: Spon & Chamberlain. [8vo, cloth, 340 p., $25.]

Catalogue of Berlin Iron Bridge Company. Complete and clear illustrations of the buildings, bridges, and general iron work of the company. Of special interest to manufacturers and engineers. East Berlin, Conn.: The Berlin Iron Bridge Co. [317 p., paper, Free on application.]

Catalogue of Niagara Stamping and Tool Company. Illustrations of Tools and Machines for Working Sheet Metal. Buffalo: Niagara Stamping and Tool Co. [104 p., Free on application.]

Chapman Valve Manufacturing Company. = Catalogue of Gate Valves and Fire Hydrants, with an Engineering Appendix. A book of great value to engineers, machinists, and all having to do with the construction or maintenance of work of all kinds. It also contains valuable articles on steam, electricity, and refrigeration. Hartford: Plimpton Press. [8vo, cloth, 146 p. Free to patrons on application.]

Cronkhite, Adelbert. = Gunnery for Non-commissioned Officers. New York: Wiley. [18mo, morocco, 450 p., $2.]

Garnsey, G. O. = The American Glossary of Architectural Terms. Being a concise and comprehensive compilation of all terms used in the practice of architecture and the building arts, with selected and original drawings. Chicago: Koelling & Klappenbach. [4to, cloth, $2.]

Goodhue, W. F. = Municipal Improvements. New York: Wiley. [12mo, cloth, 137 p., $1.50.]

Gotch, J. Alfred, and Brown, W. Talbot. = Architecture of the Renaissance in England. Illustrated by a series of views and details from buildings erected between the years 1560–1630, with historical and critical text. Boston: Ticknor. [Folio, 6 parts, paper, $8 per part.]

Goubert Manufacturing Co. (The). = Dry Steam the Foundation of Economy, with Description of The Stratton Separator. An illustrated catalogue with testimonials. New York: [8vo, paper, 36 p. Free on application.]

Grimshaw, Robert. = Engine-room Chat. New York: Practical Publishing Co. [12mo, cloth, 152 p., $1.]

Grimshaw, Robert. = Fifty Years Hence; or What May Be in 1943. A prophecy supposed to be based on scientific deductions by an improved graphical method. New York: Practical Publishing Co. [16mo, cloth, 92 p., $1.]

Haupt, Herman. = Street-Railway Motors. With descriptions and cost of plants and operation of the various systems in use or proposed for motor-power on street-railways. Philadelphia: H. Carey Baird & Co. [12mo, cloth, 213 p., $1.75.]

Hicks, I. P. = Hicks' Builders' Guide; Comprising an easy practical system of estimating material and labor for carpenters, contractors, and builders: a guide to those engaged in the various branches of the building trades. New York: Williams. [12mo, cloth, 162 p., $1.]

Hill, Robert Thomas. = On the Occurrence of Artesian and Other Underground Waters in Texas, Eastern New Mexico, and Indian Territory, West of the Ninety-Seventh Meridian. Washington: Government Printing Office. [8vo, paper, 166 p., with Maps, $1.50.]

Hofman, H. O. = The Metallurgy of Lead and the Desilverization of Base Bullion. New York: The Scientific Pub. Co. [8vo, cloth, 415 p., $6.]

Hopkins, W. J. = Telephone Lines and Their Properties. New York: Longmans, Green & Co. [12mo, cloth, 272 p., $1.50.]

Houston, Edwin J. = Electrical Measurements and Other Advanced Primers of Electricity. New York: W. J. Johnston Co. [8vo, cloth, 429 p., $2.]

Jarchow, H. N. = Forest Planting. A treatise on the care of timber lands and the restoration of denuded wood-lands on plains and mountains. New York: Orange Judd Co. [12mo, cloth, 250 p., $1.50.]

Kapp, Gisbert. = Alternating Currents of Electricity. Their generation, measurement, distribution, and application. New York: W. J. Johnston Co. [8vo, cloth, 166 p., $1.]

Keenan, W. J. and Riley, J. = The Transmitted Word. Boston: Dorchester Press Co. [12mo, cloth, 116 p., 75 cts.]

Leon, Nestor Ponce de. = Diccionario Technológico, Inglés-Español y Español-Inglés. De los terminos y frases usados en las ciencias aplicadas, artes, industriales, bellas artes, mécanica, maquinaria, minas, metalurgia, agricultura, comercio, navegacion, manufacturas, arquitectura, ingenieria, civil y militar, marina, arte militar, ferro-carriles, telegrafos, etc. New York: N. Ponce de Leon. [8vo, half leather, 873 p., $8.50.]

THE TECHNICAL INDEX.

A CATALOGUE OF LEADING ARTICLES PUBLISHED CURRENTLY IN THE TECHNICAL JOURNALS OF THE UNITED STATES AND GREAT BRITAIN.

THIS publication has been aptly described as "the greatest step that has been taken in recent years towards systematizing work" for the engineer, the architect, the electrician, the railway manager, and the business man. The list of publications regularly indexed will show that it covers a world-wide range of the best technical literature, and all the articles are so conveniently classified under general headings that within a few minutes an active man can learn of everything that has been published during the month in relation to his special lines of investigation. In short, it is to the practical man just what Poole's celebrated Index to periodicals has long been to the literary worker, but with this essential difference,—namely, that in addition to indicating *just where* leading articles have been published, *we undertake to supply copies of the articles themselves.* The unparalleled convenience and economy of this double service can readily be appreciated.

IN ordering articles from us, care should be taken to give the *number*, not the titlealone. The price of a single article is 15 cents, excepting those indicated by an asterisk (*), 30 cents, and by a dagger (†), 45 cents—according to the price of the publication quoted. All orders *must* be accompanied by cash or stamps,

To avoid frequent remittances and to cheapen the cost of articles to those who order largely, we sell coupons at the rate of 15 cents each, or 15 for $2, 40 for $5, and 100 for $12.50. Each coupon is receivable in exchange for one 15-cent article ; those marked * require two coupons, and those marked † require three coupons. This system is strongly commended. The coupons need only a trial to demonstrate their great convenience and economy of time and money.

[In the body of the index only the initials of the journals quoted are given, and these can be readily identified by the following list of periodicals. Other abbreviations are: Ill=Illustrated. w=words.]

THE AMERICAN PRESS.

A ....Arena. *m.* $5 per year. Boston.
AA......American Architect. *w.* $6. Boston.
An A A..Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
A An.... American Analyst. *f.* $1. New York.
A Ar.... American Artisan. *w.* $2. Chicago.
A & B....Architecture and Building. *w.* $6. N. Y.
A C J....Am. Chemical Journal. *b-m.* $4. Baltimore.
A E .....Architectural Era. *m.* $3. New York.
A E R J. Am. Eng. and Railroad Journal. *m.* $3. N.Y.
A G......Am. Geologist. *m.* $3.50. Minneapolis.
A G L J..Am. Gas Light Journal. *w.* $3. New York.
A H .....Annals of Hygiene. *m.* $2 per year. Phila.
A J Phar. Am. Journal of Pharmacy. *m.* $3. Phila.
A J R A..Jour. R'y. Appliances. *m.* $2. New York.
A M .....American Machinist. *w.* $3. New York.
A M & I W. Am. Man. and Iron World. $4. Pittsburg.
Am A....American Agriculturist. *m.* $1.50. N.Y.
Am G ...American Gardening. *m.* $1. New York.
Am S ...American Shipbuilder. *w.* $2. New York.
A & N J..Army and Navy Journal. *w.* $6. New York.
A & N R..Army and Navy Register. *w.* $3. Wash'ton.
A R .....Architectural Record. *q.* $1. New York.
A Rev....Architectural Review. *s-q.* $5. Boston.
A S .....Age of Steel. *w.* $3. St. Louis.
B B......Brick Builder. *m.* $2.50. Boston.
B C .....Boston Commonwealth. *w.* $2.50. Boston.
B & D...Builder and Dec. *m.* $2. Minneapolis.
B G S .. Bulletin Am. Geog. Soc. *q.* $5. N. Y.
B I S . ..Bul. Am. Iron and St. Asso. *w.* $4. Phila.
B J C ...Boston Jour. of Commerce. *w.* $3. Boston.
B & W ...Builder and Woodworker. *m.* $1. N. Y.
C....... .Compass. *m.* $1 per year. New York.
C A......Calif. Architect. *m.* $3. San Francisco.
Can A .. Canadian Architect. *m.* $2. Toronto.
C & B ... Carpentry and Building. *m.* $1. New York.
C E .....Colliery Engineer. *m.* $2. Scranton, Pa.
C E N... Canadian Elec. News. *m.* $1. Toronto.
C Eng ...Canadian Engineer. *m.* $1. Montreal.
Ch.,......Chautauquan. *m.* $2. Meadville, Pa.
C M .....Century Magazine. *m.* $4. New York.
Cos.... ..Cosmopolitan. *m.* $3 per year. New York.
D E......Domestic Engineering. *m.* $1. Chicago.
E A .....Electrical Age. *w.* $3 per year. New York.
E E N Y..Electrical Engineer. *w.* $3. New York.
E I.......Electrical Industries. *m.* $3. Chicago.
E M......Engineering Mechanics. *m.* $2. Phila.
E Mag ...Engineering Magazine. *m.* $3. New York.
E M J... Eng. and Mining Journal. *w.* $5. N.Y.
E N......Engineering News. *w.* $5. New York.
Eng .....Engineer. *s-m.* $2 per year. New York.
E N Y....Electricity. *w.* $2.50. New York.
E R......Engineering Record. *w.* $5. New York.
E R N Y..Electrical Review. *w.* $3. New York
E S W P...Proc. Eng. So. of W.Pa. *m.* $7. Pittsburg.
E W......Electrical World. *w.* $3. New York.
F ....Forum. *m.* $5 per year. New York.
F D......The Foundry. *m.* $1. Detroit.
F W......Fire and Water. *w.* $3. New York.
G & F....Garden and Forest. *w.* $4. New York.
G G M...Goldthwaite's Geograp. Mag. *m.* $2. N. Y.
G R......Good Roads. *m.* $2 per year. New York.
I A......Inland Architect. *m.* $5 per year. Chicago.
I Age....Inventive Age. *s-m.* $1. Washington.

CURRENT TECHNICAL LITERATURE.

Ir Age..Iron Age. *w.* $4.50. New York.
I I G.....Iron Ind. Gazette. *m.* $1.50. Buffalo.
I R W...India Rubber World. *m.* $3 New York.
I S F.....Industry. *m.* $2 per year. San Francisco.
I T R....Iron Trade Review. *w.* $3. Cleveland.
J A... ..Journal of Architecture. *m.* $2. Phila.
J A C S..Jour. Am. Chem. So. *m.* $5. N. Y.
J A E S..Jour. Assoc. Eng. Soc. *m.* $3. Chicago.
J F I.....Jour. Franklin Institute. *m* $5. Phila.
J M S I..Jour. Milit. Service In. *b-m.* $4. New York.
J N E W.Jour. N. E. Waterworks As. *q.* $2. New London.
J P E.....Jour. Polit. Economy. *q.* $3. Chicago.
J U S A..Jour. U. S. Artillery. *q.* $2.50. Ft. Monroe.
L E......Locomotive Engineering. *m.* $2. N. Y.
L Mag...Lippincott's Magazine. *m.* $3. Phila.
M & B...Manufacturer and Builder. *m.* $1.50. N. Y.
M & El...Mech. and Electrician. *w.* $2. St. Louis.
Met W...Metal Worker. *w.* $2 per year. N. Y.
M G......Manufacturer's Gazette. *w.* $2.50. Boston.
M I T....Mining Industry. *w.* $2. Denver.
M N.....Mechanical News. *s-m.* $1.50. New York.
M R......Manufacturer's Record. *w.* $4. Baltimore.
M R C...Marine Review. *w.* $2. Cleveland, O.
M Rec....The Marine Record. *w.* $2. Cleveland.
M S P....Min. and Sci. Press. *w.* $3. San Francisco.
M S R....Mining and Sci. Review. *w.* $2. Denver.
N A R...North American Review. *m.* $5. N. Y.
N B .....National Builder. *m.* $3. Chicago.
N C B...National Car Builder. *m.* $2. New York.
N P R...Nat. Popular Review. *m.* $2.50. Chicago.
N W.....Nowest. Architect. *m.* $3. Minneapolis.
O P D R..Oil, Paint and Drug Reporter. *w.* $6. N.Y.
P........Paving. *m.* $2. Indianapolis.
P A......Progressive Age. *s-m.* $3. New York.
P D.. ...Painting and Decorating. *m.* $1. Phila.
P E. .....Practical Electricity. *f.* $2 per year. Boston.
P E C P.Proc. Engineers' Club. *q.* $2. Phila.
P S......Power-Steam. *m.* $1 per year. N. Y.
P S M...Popular Science Monthly. *m.* $5. N. Y.
R A.....Railway Age. *w.* $4 per year. Chicago
R C J....Railroad Car Journal. *m.* $1 New York.
R G .....Railroad Gazette. *w.* $4.20 per year. N. Y.
R M.....Roller Mill. *m.* $2. Buffalo, N. Y.
R M M..Railway Master Mechanic. *m.* $1. Chicago.
R of R...Review of Reviews. *m.* $2.50. New York.
R R......Railway Review. *w.* $4 per year. Chicago.
R & T...Roofer and Tinner. *m.* $1 per year. N. Y.
R'y N....Railway News. *m.* $2. New York.
S... .....Stone. *m.* $2 per year. Indianapolis, Ind.
S A......Southern Architect. *m.* $2. Atlanta.
San......Sanitarian. *m.* $4 per year. Brooklyn.
Sc........Science. *w.* $3.50 per year. New York.
Sc A ....Scientific American. *w.* $3. New York.
Sc A S...Scientific Am. Supplement *w* $5. N. Y.
Sc M....Scribner's Magazine. *m.* $3. New York.
Sc Q... Scientific Quarterly. *qr* $2. Golden, Col.
S E .....Stationary Engineer. *w.* $2. Chicago.
Sea .....Seaboard. *w.* $2 per year. New York.
S Ec.....Social Economist. *m.* $2. New York.
S J E....Sibley Jour. of Eng. *m.* $2. Ithaca, N. Y.
S M.....Scientific Machinist. *m.* $1.50. Cleveland, O.
So L.....Sou. Lumberman. *s-m.* $2. Nashville.
S M Q.. .School of Mines Quarterly. $2. N. Y.
S R E N..St. R'y. Elec News. *m.* $2. Minneapolis.
S P......Sanitary Plumber. *s-m.* $1. New York.
S R G....Street Railway Gazette. *w.* $3. Chicago.
S R J....Street Railway Journal. *m.* $4. New York.
S R N. ..Street Railway News. *w.* $3. New York.
S R R.. .Street Railway Review. *m.* $2. Chicago.
S S .....Southern States. *m.* $1.50. Baltimore.
S V......Safety Valve. *m.* $1. New York.
T... ....Tradesman. *s-m.* $2. Chattanooga, Tenn.
T A E V.Trans. Asso. Eng'rs. of Va. Roanoke.
T A I E E.Trans. Am. Ins. Electrical Eng. *m.* $5. N. Y.
T C E... Trans. Am. Soc. Civil Eng. *m.* $10. N. Y.
T Q......Technology Quarterly. $3. Boston.
W E......Western Electrician. *w.* $3. Chicago.
W F E E.World's Fair Elec. Eng. *m.* $3. Chicago.
W G R..Water and Gas Review. *m.* $1. New York.

THE FOREIGN PRESS.

A L ....The Architect. *w.* 26s. London.
A M S.. Aust. Mining Standard. *w.* 30s. Sydney.
A P R...Aus. Pastoralists' Rev. *m.* 30s. Sydney.
B A... .The British Architect. *w.* 23s. 6d. London.
C G.. ..Colliery Guardian. *w.* 27s. 6d. London.
C R......Contemporary Review. *m.* $4.50. London.
C T J....Chem. Trade Jour. *w.* 12s. 6d. Manchester.
D........Discovery *w.* 8s. 8d. London.
E.........Engineering. *w.* 36s., London.
E E L....Electrical Engineer. *w.* 17s. 4d. London.
E G......Engineers' Gazette. *m.* 4s., London.
E L.......Electricity. *w.* 6s. 6d., London.
El.. .....Electrician. *w.* 24s. London.
Eng L... Engineer. *w.* 36s., London.
E P......Electrical Plant. *m.* 6s., London.
E R L.....Electrical Review. *w.* 21s. 8d. London.
F R......Fortnightly Review. *m.* $4.50. London.
G E M...Gas Engrs' Mag. *m.* 6s. 6d. Birmingham.
G W......Gas World. *w.* 13s., London.
I.........Iron. *w.* 30s. London.
I & S.....Iron and Steel Trades' Jour. *w.* 25s. London.
I C B.....Carpenter and Builder. *w.* 8s. 8d. London.
I C T.....Iron and Coal Review. *w.* 30s. 4d., London.
I E.......Indian Engineering. *w.* 18 Rs. Calcutta.
I L. .....Industries. *w.* 32s., London.
Inv......Invention. *w.* 28s., London.
J G L....Journal of Gas Lighting. London.
J S A....Journal of the So. of Arts. *w.* London.
K........Knowledge. *m.* 6s., London.
M.........Machinery. *m.* 9s., London.
M E......Marine Engineer. *m.* 7s. 6d. London.
M E & E J.Man. Eng. and Export Jour. *m.* London.
Min W..The Mining World. *w.* 21s. London.
M W.....Mechanical World. *w.* 8s. 8d. London.
N....... Nature. *w.* $7., London.
N C......Nineteenth Century. *m.* $4.50 London.
P Eng...Practical Engineer. *w.* 10s. London.
Pl D .....Plumber and Decor. *m.* 6s. 6d. London.
R N......Railway News. London.
R P L....The Railway Press. *m.* 7s. London.
R R L...The Railway Review. *w.* London.
R W.....Railway World. *m.* $3, London
S L......Steamship. *m.* Leith, Scotland.
S R......Sanitary Record. *m.* 10s. London.
Tr.......Transport. *w.* £1. 5s. London.
W R.....Westminster Review. *m.* $4.50. London.

ARCHITECTURE.

*12683. Sculptors of the World's Fair. Ill. J. H. Gest (E Mag-July.) 4000 w.

*12684. Mechanical Aids to Building. Ill. George Hill (E Mag-July.) 3000 w.

*12715. Painting Brickwork. Arthur Seymour Jennings (Pl D-May 1.) 1000 w.

*12716. Suggestions for Designs from Foliage—The Palm. Ill. H. Leslie Ramsey (Pl D-May 1.) 1600 w.

*12717. A Chat about Ceilings. W. N. B. (Pl D-May 1.) 1700 w.

12756. Sanitary School Buildings. Walter S. Pardee (A & B-May 13.) 4300 w.

12758. Cost of the White House (A & B-May 13.) 500 w.

*12785. Water-Tight Construction of Window Frames. Ill. I. P. Hicks (N B-May.) 1100 w.

12789. Architectural Competition for the Washington State Capitol. Editorial (E R-May 13) 1200 w.

*12832. Hygiene in its Application to the Arrangement of Buildings. P. Gordon Smith (A L-May 5.) 8800 w.

*12833. Dunblane Cathedral (A L-May 5.) 1700 w.

†12878. On the Construction of Theaters from an Optical Point of View. Ill. René De Saussure (T A E V-March.) 8300 w.

*12974 The Imperial Institute. Editorial and Description (A L-May 12.) 4000 w.

*12975. Building in Australia (A L-May 12.) 1100 w.

*12976. Oxford, Rouen, and Nuremberg (A L-May 12.) 1500 w.

*13031. Construction of Hard Wood Doors (Can A-May.) 1000 w.

13099. Iron and Steel in Building Construction. F. E. Kidder (A & B-May 27.) 3500 w.

13102. Mortar. Nomag (A & B-May 27.) 900 w.

13105. Munich (A A-May 27.) 2100 w.

*13115. On the Early Temple and Pyramid Builders. J. Norman Lockyer (N-May 18.) 5000 w.

†13146 New Convent Building, Bangalore. Ill. (I E-April 29) 700 w.

*13189. Early Christian Mosaics (A L-May 19.) 2500 w.

*13190. How to Use Vitruvius. G. Baldwin Brown (A L-May 19.) 1200 w.

*13191. The Stone Buildings of the Cotswolds. Guy Dawber (A L-May 19.) 5500 w.

*13192. St. Peter's Church, St. Albans. F. W. Kinneir Tarte (A L-May 19.) 2400 w.

†13200. Stained Glass as an Architectural Adjunct. W. A. Hazel (I A-May.) 2600 w.

†13201. The Development of Tile Fireproof Construction (Abstract). R. Gustavino (I A-May.) 2000 w.

13210. The Ups and Downs of the Profession. Max Drach (S A-June.) 2500 w.

13214. Erection of Scaffolds (C & B-June.) 800 w.

13215. Competition in Store Fronts. Ill. (C & B-June.) 900 w.

13243. Building Ordinances of the City of Chicago (E N-June 1.) 1600 w.

*13251. The City of Brooklyn. Ill. Murat Halstead (Cos-June.) 4300 w.

*13336. The Architectural Schools of the United States. Edward C. Earl (Tech-No. 7.) 3000 w.

13349. Royal Victoria Hospital at Montreal. Ill. (E R-June 3) 1500 w.

*13374. The Amphitheatre at Arles (A L-May 26.) 1600 w.

*13375. Nunraw Castle (A L-May 26.) 1400 w.

*13376. The Valuation of Property. G. V. Blackburne (A L-May 26) 3500 w.

*13406. Roofing Tiles.—Why not Have More Variety? (B B-April.) 1400 w.

*13425. The Superintendence of Buildings (N B-June.) 1200 w.

13428. Improved Building Construction. Ill. (M & B-May.) 1700 w.

13430. Hollow Building Blocks of Brick. Ill. (M & B-May.) 400 w.

†13468. The Study of Architecture. Francis W. Chandler (T Q-Dec) 2500 w.

13484. The Care of Finished Woodwork. Owen B. Maginnis (M N-June 1.) 900 w.

Serials.

7121. Office-Help for Architects. Ill. George Hill (A A-Began Oct. 8—12 parts to date—15 cts. each).

9508. Ideality in Architecture. J. C. Worthington (J A-Began Dec.—2 parts to date—30 cts. each).

12409. Color in House Decoration. A. S. Barbier (A & B-Began April 29—Ended May 13—2 parts—15 cts. each).

12414. Side Lights on Viollet-le-Duc. Massillon Rouvet (A A-Began April 29—3 parts to date—15 cts. each).

12568. Building Construction and Superintendence. Ill. F. E. Kidder (A & B-Began May 6—3 parts to date—15 cts. each).

12569 The Value of Criticism. C. J. Tait (A & B-Began May 6—Ended May 20—2 parts—15 cts. each).

12963. Commemorative Monuments. Ill. L. C. Boileau (A A-Began May 20—2 parts to date—15 cts. each).

12966. An Architectural Knock-About. Ill. F. L. V. Hoppin (A A-Began May 20—2 parts to date—15 cts. each).

13093. Laying Steel Roofing. Ill. L. S. Bonbrake (Met W-Began May 27—1 part to date—15 cts).

13358. Modern Asylums for the Insane. George H. Bibby and Ernest A. E. Woodrow (A A-Began June 3—1 part to date—15 cts).

13407. Terra-Cotta and Faience as Materials for Architectural and Decorative Application (B B–Began April—1 part to date—30 cts).

CIVIL ENGINEERING.

†12705. Colombo Harbor. Editorial (I E–April 8.) 1200 w.

†12706. Colombo Harbor. Ill. John Coode (I E–April 8.) 4500 w.

†12708. The Diary of a Recalcitrant Well. Ill. F. J. E. Spring (I E–April 8.) 1200 w.

†12733. A Note on Pin-Plates, with Discussion. Ill. Thomas H. Johnson (E S W P–March.) 3800 w.

†12740. The Reconstruction of Ninth Street Bridge, Pittsburg, Pa., with Discussion. Ill. Gustave Kaufman (E S W P–Vol. VIII.) 10000 w.

12746. The Stability of Foundations under Varying Angles of Load-Application. Ill. James L. Greenleaf (E N–May 11.) 800 w.

†12871. Public Highways and Roads in Virginia.—Their Construction and Maintenance. Oscar Saabye (T A E V–March.) 3300 w.

†12874. Description of Methods Used in the Construction of the Iron Coal Pier, Norfolk and Western Railroad Company, at Lambert's Point, Norfolk, Va. W W. Coe (T A E V–March.) 1500 w.

12937. Common Sense in the Improvement of Country Roads (E N–May 18.) 1750 w.

12939. The Boucicault Bridge. Ill. (E N–May 18.) 1800 w.

*12992. Natural and Artificial Cements in Canada. H. P. Brumell (C T J–May 13.) 600 w.

12996. The Evolution of Bridge Trusses. Ill. Mansfield Merriman (R A–May 19.) 4200 w.

*13004. Theory and Practice. (Extract) Benjamin Baker (El–May 12.) 1000 w.

*13010. The Richmond Lock and Tidal Weir, with Discussion. Ill. J. B. Hilditch (J S A–May 12.) 8500 w.

*13028. Bridge Construction in Austria. Ill. (I L–May 12.) 200 w.

13087. Depositing Dredged Material on the Land (E N–May 25.) 600 w.

13089. Cumulative Vibrations in Bridge Trusses. Ill. (E N–May 25.) 900 w.

13108. Long Spans and High Piers (R G–May 26.) 450 w.

*13129. Failure of a Bridge in Servia. Ill. (Eng L–May 19.) 1300 w.

13134. Improvements of the James River Virginia. H. D. Whitcomb (E R–May 27.) 1200 w.

13137. The Cost of Bad Roads (E R–May 27.) 950 w.

*13159. The New Harbor Works at Genoa (Ti–May 19.) 1200 w.

*13172. Richmond Lock and Weir. Ill. (E–May 19.) 3000 w.

13233. Locks of the Nicaragua Canal and the St. Mary's Falls Canal (E N–June 1.) 4800 w.

13237. The Pay and Standing of Civil Engineers (E N–June 1.) 1800 w.

*13261. Holding Power of Anchor Bolts in Stone. E. F. Milner (P Eng–May 26.) 850 w.

*13268. Deep Water from the Great Lakes to the Ocean. L. E. Cooley (J A E S–April.) 4200 w.

*13269. Our Pavements. John Donnelly (J A E S–April.) 2200 w.

*13291. The Origin of Asphalt. D. Torrey (P–June.) 1800 w.

*13292. Brick Street Pavements in Towns (P–June.) 1000 w.

*13294. Natural and Artificial Cements. Spencer B. Newberry (P–June.) 4800 w.

*13328. Deep Pile Foundations for Chicago. William Sooy Smith (Tech–No. 7.) 1000 w.

*13329. A Deep Pile Foundation. C. J. Mitchell (Tech–No. 7.) 1200 w.

*13330. A Bit of Experience with Piles in Chicago. Simeon C. Colton (Tech–No. 7.) 350 w.

*13332. The Pont-y-Prydd Arch. Ill. W. D. Pence (Tech–No. 7.) 2000 w.

*13333. Transverse Strength of Brick Masonry. M. A. Earl and A. B. Loomis (Tech–No. 7.) 2200 w.

*13337. Shop Inspection of Bridges. C. O. Baughman (Tech–No. 7.) 1400 w.

*13339. Relative Cost of Heavy vs. Reinforced Bridges. Albert F. Robinson (Tech–No. 7.) 1000 w.

13359. One of the World's Wonders—A Great Canal in the Crimea (B J C–June 3.) 750 w.

13455. Silica Gravel Concrete (E N–June 8.) 700 w.

13461. The Accident of the Austin Dam (E N–June 8.) 400 w.

13480. The Erie Canal (M Rec–June 8.) 1150 w.

13482. The New Blackwall Tunnel under the Thames. W. N. B. (M N–June 1.) 800 w.

Serials.

9740. Proposed New Road-Bridge Across Darling Harbor, Sydney. Ill. (I L–Began Jan. 6—Ended May 19—4 parts—30 cts. each).

10780. Dredging. W. H. Wheeler (Eng L–Began Feb. 17—Ended May 12—4 parts—30 cts. each).

12312. Theory of a Parabolic Arch with Three Pivots (Eng L–Began April 14—Ended May 19—2 parts—30 cts. each).

12510. The Gravel Movement in Parke County, Indiana. J. T. Campbell (P–Began May—2 parts to date—30 cts. each).

12561. Road-Law in Switzerland. Ill. Edgar R. Dawson (G R–Began April—2 parts to date—30 cts. each.

13009. Strains in Beams and Girders. Ill. John Wright Seaver (E R-Began May 20—1 part to date—15 cts).

13194. Highway Bridges. Ill. John N. Ostrom (G R-Began May—1 part to date—30 cts).

13420. The Sher Shah Bridge, over the River Chinab, near Multan, Punjab. Ill. Francis J. E. Spring (I E-Began May 6—1 part to date—45 cts).

ELECTRICAL MISCELLANY.

12694. The Telectroscope.—Vision at Great Distances by Electricity. Ill. Leon Le Pontois (E N Y-May 10.) 3000 w.

12696. Dynamoters, or Direct Current Transformers. Prof. Crocker (E N Y-May 10.) 1500 w.

12720. Edison's Improvement in the Transmission of Power. Ill. (Sc A-May 13.) 900 w.

12754. The Geomagnetifere. Ill. C. Crepaux (W E-May 13.) 1100 w.

†12771. Tables and Discussion of A. E. Kennelly's Paper on "Impedance" (T A I E E-May.) 7500 w.

†12772. The Action of Continuous and Alternating Currents on Fuse Metals. Ill. C. P. Matthews (T A I E E-May.) 4000 w.

†12773. A Modified Deprez-D'Arsonval Galvanometer. Ill. Charles D. Parkhurst (T A I E E-May.) 4200 w.

†12774. An Automatic Printing Speed Counter for Dynamo Shafting. Ill. George S. Moler (T A I E E-May.) 1400 w.

*12820. Electrical Nomenclature. Editorial (E R L-May 5.) 1500 w.

*12823. Dynamo Graphics. Ill. Arthur H. Allen (E R L-May 5.) 450 w.

*12824. Fault Finding in Conductors. (Extract) M. Kallmann (E R L-May 5.) 900 w.

*12825. Prime Movers for Small Power Generating Plants (E R L-May 5.) 1800 w.

*12826. Progress in Electrical Measurement.—The Reckenzann-Binswanger Meter. Ill. (E R L-May 5.) 2800 w.

*12830. Electricity and Electrical Appliances. W. E. Ayrton (E E L-May 5.) 3500 w.

*12831. Practical Electrical Problems at Chicago, with Discussion. Silvanus P. Thomson (J S A-May 5.) 7200 w.

*12844. Dynamos for Lecture Purposes. Ill. (E L-May 5.) 700 w.

12850. An American Gauntlet Thrown to the British Board of Trade.—Mechanical Power the Only True Standard to Measure Electrical Energy By. F. M. F. Cazin (E A-May 20) 1800 w.

12853. Utilizing Electric Motors for Operating Machinery. Ill. (E R N Y-May 20.) 1500 w.

12856. On the Proposed Practical Magnetic Units.—Gilbert, Weber, Oersted, and Gauss. A. E. Kennelly (E W-May 20) 2200 w.

12862. The Preparation of Gelatinous Electrolyte for Storage Batteries. Ill. Paul Schoop (E E N Y-May 17.) 2200 w.

12864. The Crocker Wheeler Model Factory Operated without Shafting. Ill. (E E N Y-May 17.) 1000 w.

*12881. Electricity at the World's Fair. Igleheart (Ch-June.) 2600 w.

12885. Steam and Electric Plant at the Virginia Hotel, Chicago. Ill. (S E-May 6.) 1500 w.

12913. First Public Exhibition of Edison's Kinetograph (Sc A-May 20.) 1000 w.

12921. International Congress of Electricians at Chicago. E. Hospitalier (W E-May 20.) 1650 w.

12951. Electrical Standard Units. F. M. F. Cazin (E A-May 27.) 1300 w.

*12982. Starting of Synchronous Alternators. Ill. Camillo Olivetti (E R L-May 12.) 600 w.

*12985. Electricity and National Economy. E. Tremlett Carter (E R L-May 12.) 1000 w.

*13003. Crompton's Potentiometer Method of Obtaining Accurate Electrical Measurements. Ill. (El-May 12.) 1800 w.

13011. Relations Between Electrical and Insurance Interests. J. A. Waterworth (A G L J-May 22.) 2600 w.

*13016. Earth Currents in India. Ill. E. O. Walker (E E L-May 12.) 1700 w.

*13018. The Condensing Plant, London Electric Supply Corporation. Ill. (Eng L-May 12) 1400 w.

13040. Differential Meter Clock. Ill. Design of Gisbert Kapp (E W-May 27.) 1300 w.

13041. The Pentz-Reckenzann Electric Meter. Ill. (E W-May 27.) 1300 w.

13047. Electrical Theory. Albert L. Arner (E E N Y-May 24.) 1400 w.

13049. Single Phase Alternating Motors. Ill. (E E N Y-May 24.) 450 w.

13095. Practical Applications of Electric Heating. Ill. (W E-May 27.) 400 w.

*13149. On the Prevention and Control of Sparking; Continuous Current Dynamos without Winding on the Field Magnets, and Constant-Pressure Dynamos without Series Winding. Ill. W. B. Sayers (E E L-May 19.) 4300 w.

*13175. The Value of Combination Stations (E R L-May 19.) 2800 w.

*13177. Nicety in Terms and Accuracy in Definition.—"Considerations for Town Councillors" (E R L-May 19.) 1600 w.

*13193. The Accuracy of the Copper Voltameter. Bertram Blount (El-May 19) 1900 w.

13250. Electric Heating. Carl K. MacFadden (E N Y-May 31.) 2500 w.

13267. Propositions for the Consideration of the Electrical Congress. E. Hospitalier (W E-June 3.) 1400 w.

13273. Heating of Armatures. A. H. and C. E. Zimmerman (S R N-June 3.) 2700 w.

*13309. On the Dissipation of Electricity by

Diffused Light and in the Dark. Edouard Branly (El-May 26.) 1000 w.

*13310. The Taper of Commutation Sections. Ill. (El-May 26) 900 w.

*13311. The Magnetic Curve Tracer. Ill. Prof. Ewing (El-May 26.) 1800 w.

*13313. On the Reaction of the Armature Current on the Field. Ill. J. Fischer-Hinnen (El-May 26.) 2000 w.

*13318. Wet and Dry Cells. Sydney F. Walker (E E L-May 26.) 1200 w.

*13346. Electric Cooking and the Load Factor (E R L-May 26.) 1300 w.

*13348. Relation of Volta Electromotive Force to Pressure, Etc. (E R L-May 26.) 1500 w.

13351. The Johnson Electrical Heat Regulating Apparatus, as Applied in the Public Schools of Chicago. Ill. E. T. Ackerman (S E-May 27.) 2000 w.

*13353. Stabilit.—A New Insulating Material (E L-May 26.) 600 w.

13377. Revolution in Electric Heating. Editorial (A S-June 3.) 600 w.

*13391. The Electric Heater. T. Ahearn (E I-June.) 1200 w.

*13392. Electric Heating. S. B. Jenkins (E I-June.) 2500 w.

13397. Electrical Measuring Instruments. Ill. L. M. Pinolet (C E N-June.) 1500 w.

13398. Mica for Armature Insulation (C E N-June.) 900 w.

13402. Electrical Notation, Abbreviations and Symbols (E W-June 10.) 150 w.

13403. The Student Course at Lynn. John R. Pitman (E W-June 10.) 2000 w.

13404. Electrolytic Corrosion of Piping System in the Neighborhood of Grounded Electric Circuits. Frederic A. C. Perrine (E R N Y-June 10.) 1500 w.

13405. A Visit to Mr. Edison's Laboratory. J. A. M. (E R N Y-June 10.) 1400 w.

†13469. The Action of Compound Dynamos When Run in Parallel. Ill. William L. Puffer (T Q-Dec.) 6500 w.

Serials.

3500. Theoretical Elements of Electro-Dynamic Machinery. Ill. A. E. Kennelly (E E N Y-Began April 20, 1892—19 parts to date—15 cts. each).

10843. Conductors and Insulators. Ill. Reginald A. Fessenden (E W-Began March 4—6 parts to date—15 cts. each).

11501. Theory of the Transformer. Ill. F. Bedell and A. C. Crehore (E W-Began March 25—4 parts to date—15 cts. each).

11560. Electricity as a Motive Power. Albion T. Snell (El-Began March 17—5 parts to date—30 cts. each).

12311. On Lightning Rods (E R L-Began April 14—Ended May 12—2 parts—30 cts. each).

12514. The Condenser in Alternate Current Power Distribution. Ill. William Stanley, Jr. (E E N Y-Began May 3—3 parts to date—15 cts. each).

12668. Non-Synchronous Alternating Current Motors. Dr. Behn-Eschenburg (E W-Began May 13—2 parts to date—15 cts. each).

12847. A Year's Electrical Progress in the United States of America (Inv-Began May 6—3 parts to date—30 cts. each).

12950. The Action of Continuous and Alternating Currents on Fuse Metals. C. P. Matthews (E A-Began May 27—2 parts to date—15 cts. each).

13013. Alternate Current Transformer Design. R. W. Weekes (E E L-Began May 12—3 parts to date—30 cts. each).

ELECTRIC LIGHTING.

*12828. Concentric Wiring. Sydney F. Walker (El-May 5.) 1500 w.

12859. The Great Switchboard of the Westinghouse Exhibit. Ill. (E W-May 20.) 5200 w.

†12870. Specifications of First Class House Wiring for Electric Light. Robert Cummings (T A E V-March.) 2000 w.

12901. The Novak Lamp with Brief Sketch of the Inventor. Ill. (E N Y-May 17.) 600 w.

*13005. A New Form of Portable Photometer, with Discussion. Ill. David Salomons (El-May 12.) 4000 w.

13044. The So-Called Neutral Wire in Lighting Systems (E R N Y-May 27.) 850 w.

13048. The Ideal Electric Meter. W. G. Stratton (E E N Y-May 24.) 1350 w.

13152. On Light and Other High Frequency Phenomena. Ill. Nikola Tesla (E W-June 3.) 27500 w.

*13176. The Wiring of Houses for the Electric Light (E R L-May 19.) 1400 w.

13198. Bombe and Suchard's Combined Arc Lamp and Incandescent Lamp System. Ill. (E R N Y-June 3.) 1000 w.

*13312. The Continuous Control of Electric Light Cable Systems. Ill. M. Kallmann (El-May 26.) 1000 w.

*13344. The Cost of Private Electric Supply. Ed C. de Segundo (E R L-May 26.) 3000 w.

13360. Light Without Heat. Experiments of Prof. Pupin (B J C-June 3.) 700 w.

13399. On Light and Other High Frequency Phenomena (E W-June 10.) 1000 w.

13401. Windmills for Electric Lighting. George H. Morse (E W-June 10.) 2000 w.

Serials.

6709. Electric Light and Power. Arthur F. Guy (E E L-Began Sept. 9—21 parts to date—30 cts. each).

GAS ENGINEERING.

*12692. The Natural Gas Supply Limited. S. S. Gorby (E Mag-July.) 3000 w.

*12704. A Description of the Yeadon Rotary System of Gas Making, with Discussion. D. Terrace (J G L–May 2.) 5000 w.

12788. Mammoth Gas Holder Recently Constructed for the Chicago Gas Light and Coke Company, at the Station, Deering and Cologne Streets. Ill. (A G L J–May 15.) 1800 w.

*12851. Gasification of Coals and Liquid Hydrocarbons, with Discussion. P. Dvorkovitch (G W–May 6.) 3700 w.

*12918. Hislop's Regenerative Retort-Settings, and Experience in the Working of Same. Ill. Er. W. Smith (J G L–May 9.) 1800 w.

12935. Ammonia Gas as a Source of Motive Power. T. Waln-Morgan Draper (E N–May 18.) 2000 w.

*12990. Enriching Gas at Home and Abroad (G E M–May 10.) 2500 w.

*12991. Coal Gas: Its Possibilities in Relation to Our Home and Export Trades. T. E. P. (G E M–May 10.) 3000 w.

*13019. Hydraulic Coke Stacking Crane—Saltley Gas Works. Ill. (Eng L–May 12.) 700 w.

*13051. Inaugural Address of Mr. John Methoven (J G L–May 16.) 5500 w.

*13052. Differential Prices for Gas. George Livesey (J G L–May 16.) 2300 w.

*13053. Carburetted Water Gas. Vivian B. Lewes (J G L–May 16.) 3500 w.

*13054. Carburetted Water-Gas Apparatus. A. G. Glasgow (J G L–May 16.) 1800 w.

*13055. Notes on the Application of Oxygen to Lime Purification at Shrewsbury. W. Belton (J G L–May 16.) 4600 w.

*13056. Thoughts on Carbonizing, Suggested by the Yeadon Revolving Retort (J G L–May 16.) 1400 w.

*13057. Constant District Pressure Automatically Maintained. Ill. Mr. Cowap (J G L–May 16.) 2000 w.

13118. Competitive Tests of Gas-Saving Appliances at Pittsburg Exposition. Ill. (A M & I W–May 26.) 1400 w.

*13133. Large Gas Engines vs. Steam Power (Eng L–May 19.) 1400 w.

13150. Notes on Oxide of Iron Purification. E. G. Love (A G L J–May 29.) 1750 w.

13262. Residuals.—Ideas Concerning Them Suggested by the Outlook. James Ferrier (P A–June 1.) 1200 w.

13263. Wrinkles. Ill. George T. Thompson (P A–June 1.) 2500 w.

13264. The Duty of Gas Companies to Their Customers. H. D. Walbridge (P A–June 1.) 2000 w.

13265. Gas Analysis. Ill. O. O. Thwing (P A–June 1.) 2000 w.

13266. Wood Gas During the War. Jas. R. Smedberg (P A–June 1.) 3000 w.

*13280. The Application of Weldon Mud to Gas Purification. J. J. Hood and J. Gordon Salamon (J G L–May 23.) 6000 w.

*13281. Inclined Retorts at the Coventry Gas Works. George Winstanley (J G L–May 23.) 2800 w.

*13282. Improved System of Working Inclined Retorts. J. F. Braidwood (J G L–May 23.) 1500 w.

*13283. The Application of Machinery for Working Horizontal Retorts. C. C. Carpenter (J G L–May 23.) 3500 w.

*13284. Discussion on Mr. George Livesey's Paper on "Differential Prices for Gas" (J G L–May 23) 8000 w.

*13285. Discussion on the Papers by Prof. Lewes and Mr. Glasgow on "Carburetted Water Gas" (J G L–May 23.) 9500 w.

*13286. The Capital Invested in Gas Undertakings, and the Consumers of Gas. Norton H. Humphrys (J G L–May 23.) 1200 w.

*13335. Gas Engine Valve Setting. Ill. W. H. Cornell and B. V. Swenson (Tech-No. 7.) 1000 w.

*13416. Discussion of Paper by J. J. Hood and J. Gordon Salamon on the Application of Weldon Mud to Gas Purification (J G L–May 30.) 5500 w.

*13417. Discussion of Papers by Messrs. Winstanley, Braidwood, and Carpenter, on Working Inclined and Horizontal Retorts (J G L–May 30.) 5500 w.

*13418. The Mathematics of Washers and Scrubbers (J G L–May 30.) 900 w.

*13419. The Peebles Oil-Gas Process from a Southern Point of View. John T. Sheard. (J G L–May 30.) 1800 w.

Serials.

11993. Oxide of Iron: A Monograph. John T. Sheard (J G L–Began April 4—Ended May 2—5 parts—30 cts. each).

HYDRAULICS.

†12734. The Water Supply of Pittsburg and Allegheny City. James H. Harlow (E S W P–March.) 5000 w.

†12737. Discharge Observations of Large Streams, with Discussion. George S. Davison (E S W P–Vol. VIII.) 10000 w.

†12745. The Construction of Iron and Steel Water Tanks. William C. Coffin, Jr. (E S W P–Vol. VIII.) 1500 w.

12790. Leakage Through an Earthen Dam. Ill. (E R–May 13.) 1200 w.

12791. The Chattanooga Filter Plant. Ill. (E R–May 13.) 1000 w.

†12865. Irrigation in the Arid States. Ill. Charles Howard Shinn (P S M–June.) 3000 w.

†12879. The Construction of a Water-Tight Masonry Dam. Ill. Walter McCulloh (T C E–March.) 4500 w.

12914. The New Water Supply for Paris.—The Water of the Vigne and Avre. Ill. (Sc A S–May 20.) 500 w.

†12923. The Ancient Water-Works of Aurungabad. Vibgyor (I E–April 15.) 1200 w.

12929. The Water-Power at Columbia, S. C. (M R–May 19.) 1000 w.

13066. Terms of Water Measurement for

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†13072. The Modern Water-Works of Aurungabad (I E–April 22.) 1500 w.

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13113. Driven Well Supply. Peter Milne (F W–May 27.) 1700 w.

13135. The Great Falls Submerged Conduit. Ill. (E R–May 27.) 700 w.

†13145. Report of Mr. Baldwin Latham on the Drainage of Cairo (I E–April 29.) 1500 w.

13216. The Value of Irrigation. J. W. Powell (M S P–May 27.) 1300 w.

*13271. Construction of the Wooden Pipe Line for Butte City Water-Works. Ill. Fred P. Gutelius (J A E S–April) 3000 w.

*13272. The Niagara Turbines. Ill. Clemens Herschel (R M–May.) 1700 w.

*13334. A Big Siphon. Ill. J. N. Chester (Tech–No. 7.) 500 w.

*13369. Water Supply from Deep Wells. Editorial (E–May 26.) 900 w.

13413. The Storage of Water for Irrigation (M S P–June 3.) 900 w.

13451. The New Artesian Water Supply at Savannah, Ga. Ill. (E N–June 8.) 3000 w.

13453. How Venetian Wells Were Made (E N–June 8.) 400 w.

13458. The Air-Lift Pump. Ill. (E N–June 8.) 6000 w.

13460. Regulating the Rate of Filtration through Sand. Ill. William K. Burton (E N–June 8.) 1400 w.

†13471. A Method of Estimating the Loss of Water Power in a Stream by Taking Water Therefrom for a City Supply, with Discussion. L. M. Hastings (J N E W–June.) 7000 w.

†13472. Location of Broken Mains and Examination of Hydrants in Cold Weather. George A. Stacy (J N E W–June.) 700 w.

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*12685. Development of the Modern Steam Pumping-Engine. Ill. William W. Barr (E Mag–Began July—1 part to date—30 cts).

13343. The River Nile. Ill. H. Droop Richmond (J A C S–Began Jan.—1 part to date—45 cts).

INDUSTRIAL CHEMISTRY.

†12893. The Chemist in German Rubber Factories. H. C. van Rylin (I R W–May 15.) 1000 w.

*12977. The Appreciation of Science by German Manufacturers. Ill. Henry E. Armstrong (N–May 11.) 4500 w.

*13030. Technical Chemistry at Burlington House (I L–May 12.) 900 w.

†13058. A Modification of the Stannous-Chloride Method for Iron Titrations. R. W. Mahon (A C J–May.) 900 w.

13202. The Industrial Uses of Sodium Silicate (Sc A–June 3.) 500 w.

13380. Iron and Aluminum in Bone Black: Their Quantitative Determination. F. G. Weichmann (Sc–June 2.) 1500 w.

13437. Skim Milk for Manufacturing Purposes. J. Carter Bell (Sc A S–June 10.) 3500 w.

Serials.

12603. Facts and Figures on Electrolytic Chlorine and Soda. Emile Andreoli (E R L–Began April 28—3 parts to date—30 cts. each).

13001. Some Applications of Electricity to Chemistry. James Swinburne (P Eng–Began May 12—1 part to date—30 cts).

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*12686. The Financial Situation. Matthew Marshall (E Mag–July.) 3000 w.

*12687. The Weak Points of Trade Unionism. Lawrence Irwell (E Mag–July.) 3000 w.

12701. No Time to Advance Wages. Editorial (Ir Age–May 11.) 600 w.

12718. American Boys and American Labor. (Sc A–May 13) 1300 w.

12755. The Thiele Bill and Socialism. Allen R. Foote (W E–May 13). 1600 w.

†12769. Will Socialism Be a Remedy for Present Social Ills? J. Russell Endean (W R–May.) 8000 w.

†12770. The Eight Hour Question. J. T. Blanchard (W R–May.) 13000 w.

12777. The Pity of It. Editorial (M G–May 13.) 1200 w.

12787. Employer and Employé.—A Remedy for the Antagonism that Exists Between Railways and Their Employés. J. H. Kelly (R A–May 12.) 1800 w.

*12798. Arbitration and Conciliation in Labor Disputes. Editorial (E–May 5.) 2500 w.

*12805. The Employer's Liability Question in Germany (I L–May 5.) 700 w.

*12825. The Relations Between Employers and Workmen in Engineering Works. C. R. Lorus (I & S–May 6.) 5200 w.

*12841. The Dockers' Conflict in London and Hull. Editorial (Tr–May 5.) 2500 w.

*12882. The Social Condition of Labor. E. R. L. Gould (Ch–June.) 2300 w.

†13006. The Relation of Economic Conditions to the Causes of Crime. Carroll D. Wright (An A A–May.) 7000 w.

13119. Cost of Strikes in Great Britain. Editorial. (A M & I W–May 26.) 500 w.

*13158. The Terms of Peace, and Outlook at Hull (Tr–May 19.) 1400 w.

*13165. A Shorter Working Day.—Review of book by R. A. Hadfield and H. de B. Gibbins (E–May 19.) 2800 w.

*13169. Labor Questions in Canada and Newfoundland. Editorial (E–May 19) 2200 w.

*13223. The Tyranny of Brotherhoods. G. A. Brown (N C B–June.) 900 w.

†13229. Who Are the Chief Wealth Producers? W. H. Mallock (N A R–June.) 5800 w.

*13301. The End of the Hull Strike. Editorial (Eng L–May 26.) 1700 w.

13444. Uneasiness Among Stove Molders. Editorial (Ir Age–June 8.) 1000 w.

Serials.

12972. "Never Do Anything Except What You Are Paid For Doing." W. H. Wakeman (M G–Began May 20—Ended May 27—2 parts —15 cts. each).

LANDSCAPE ENGINEERING.

12886. The Care of Newly Planted Trees (G & F–May 17.) 1450 w.

12887. New England Parks.—Putnam's Wolf Den, Pomfret, Conn. M. C. Robbins (G & F–May 17.) 1500 w.

13046. The Park Movement in the United States (G & F–May 24.) 1800 w.

13101. Possibilities in Landscape Gardening (A & B–May 27.) 800 w.

MARINE ENGINEERING.

*12710. The Land of the Midnight Sun—A New Mail and Tourist's Steamer (M E–May 1.) 1000 w.

12762. Belleville Boilers. Ill. Miers Coryell (M R C–May 11.) 1000 w.

12786. Lighthouse Illuminants. William P. Anderson (Sc–May 12.) 1200 w.

*12809. Shipbuilding in France (Eng L–May 5.) 1000 w.

12903. How Boats are Made of Paper (M N–May 15.) 350 w.

12932. Joseph Francis. Ill. (Sea–May 18.) 1300 w.

12959. Captain McDougall, the Marine Transportation Wizard of the North-west (M Rec–May 18.) 1500 w.

12960. What are the Results of the International Marine Conference? Editorial (M Rec–May 18.) 1000 w.

*12935. The Suez Canal Traffic (Tr–May 12.) 600 w.

*13025. The Report of the Admiralty Boiler Committee. Editorial (E–May 12.) 3800 w.

13069. The Draughtometer. Ill. (Sc A S–May 27.) 1400 w.

13090. Queen of the Lakes—The Whaleback Propeller Christopher Columbus. Ill. (Sea–May 25.) 3000 w.

*13128. Towing by Magnetic Adhesion. Ill. (Eng L–May 19.) 2800 w.

*13131. Ship Canals. Editorial (Eng L–May 19.) 1600 w.

13138. Yachting at the Fair.—A Lake Association. Robert Rae (M R C–May 25.) 1400 w.

*13160. International Bills of Lading (Tr–May 19.) 1200 w.

*13170. The Registry of Ships. Editorial (E–May 19.) 1400 w.

13206. The Repairs to the Hull of the "Great Eastern" While Afloat. E. S. Renwick (A M–June 1.) 3000 w.

†13231. Thirty Knots an Hour to Europe.—Possibilities of Speed on the Atlantic. J. H. Biles (N A R–June.) 5000 w.

13248. World's Fair Excursion Steamers. Ill. (Sea–June 1.) 1200 w.

13255. Oil Fuel for Steamships (T–June 1.) 500 w.

*13288. Vasca da Gama's Ship, the "San Gabriel" (A E R J–June.) 2300 w.

13363. Condensers of a Large Cruiser. Ill. A. B. Willits (M R C–June 1.) 650 w.

*13367. A New Type of Cargo Steamer. Ill. (E–May 26.) 4800 w.

*13414. On the Speed Constants of Ships. Francis Elgar (S L–June.) 1000 w.

*13415. Automatic Ship Loaders and Dischargers. Ill. (S L–June.) 500 w.

*13438. How It Happened the S. S. Glendarroch Stranded (E G–June.) 1800 w.

13449. Our Flag at Sea. William W. Bates. (Sea–June 8.) 1300 w.

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12802. On Testing Machinery and Electric Water-Level Recording Apparatus. Ill. John Barr (M W–Began May 5—Ended May 19—2 parts—30 cts. each).

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†12736. A Rapid Method for Phosphorus Determination in Iron, Steel, and Ores, with Discussion. James O. Handy (E S W P–Vol VIII.) 2500 w.

†12738. Iron Mill Buildings, with Discussion. Ill. John W. Seaver (E S W P–Vol. VIII.) 10000 w.

†12741. Mill Building Construction with Details from Practice, with Discussion. Ill. George Hunt Hutchinson (E S W P–Vol. VIII.) 11500 w.

†12742. The World's Supply of Nickel, with Discussion. Joseph H. Eastwick (E S W P–Vol. VIII.) 5500 w.

†12744. Note on the Use of Hot Acid in the Evolution of Sulphur as $H_2 S$ from Pig-Iron, with Discussion. Frederick H. Williams (E S W P–Vol. VIII.) 2200 w.

12783. Hardening Steel (Eng–May 13.) 750 w.

*12810. Saniter's Process for Desulphurizing Iron and Steel (Eng L–May 5.) 1700 w.

†12867. The Assay of Low-Grade Impure Tin Ore. Robert Peele, Jr. (S M Q–April.) 950 w.

*12884. Aluminum the Substitute for Iron. J. Fleury (Ch–June.) 2200 w.

12888. Magnetic Separation of Ores. Editorial (M S P–May 13.) 600 w.

12916. The Assay of Gold (Sc A S–May 20.) 900 w.

*12919. Application of the Intense Heat of Gas to the Superficial Transmutation of Metals. Ill. (J G L–May 9.) 3500 w.

*12979. The Estimation of Chromium in Steel. John Clark (I–May 12.) 1800 w.

*12986. The Manufacture of Steel in Small Converters (C G–May 12.) 700 w.

*12987. The Sampling and Analysis of Iron Ores. Walter J. May (C G–May 12.) 1000 w.

*13029. Experiments on Rolled Joists of Bessemer Basic Steel. Ill. (I L–May 12.) 700 w.

13065. Testing Ores for Working Process. C. H. A. (M S P–May 20.) 3000 w.

13076. "Keep's Test" for Cast Iron. Letters from W. J. Keep and E. H. Mumford (A M–May 25.) 1000 w.

13078. Iron and Steel in the Western States. W. M. Sweet (Ir Age–May 25.) 1500 w.

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13094. The American Tin-Plate Situation (Met W–May 27.) 1200 w.

13114. Bog Ores and Ancient Forges of Radnor. Ill. (C Eng–May.) 2800 w.

*13154. Economic Method for the Production of Steel (C G–May 19.) 1800 w.

*13155. The Competition in the Hematite Pig Iron Trade (C G–May 19.) 1000 w.

*13182. Estimation of Chromium, Copper, Nickel, Manganese, and Phosphorus in Steel. A. Ziegler (I–May 19.) 1900 w.

*13188. The Manufacture of Charcoal Iron from the Bog and Lake Ores of Three Rivers

District, Province of Quebec, Canada. P. H. Griffin (I & S–May 20.) 8000 w.

13203. Colors from Iron Ores. Walter J. May (Sc A S–June 3.) 900 w.

13218. Copper in Engineering Construction (Ir Age–June 1) 2000 w.

*13270. On Some Physical Properties of Steel as Related to Its Composition and Structure, with Discussion. John W. Langley (J A E S–April.) 7500 w.

*13299. Blowing Engines for Luxemburg Blast Furnaces. Ill. (Eng L–May 26.) 2500 w.

*13300. Presidential Address of Windsor Richards (Eng L–May 26.) 5800 w.

*13304. On the Elimination of Sulphur from Iron. J. E. Stead (C G–May 26.) 5000 w.

*13305. A New Process for Desulphurizing Iron and Steel. E. H. Saniter (C G–May 26.) 2400 w.

*13306. The Recording Pyrometer. W. C. Roberts-Austen (C G–May 26.) 1350 w.

*13307. The Manufacture of Basic Steel at Witkowitz. Paul Kupelwieser (C G–May 26.) 1400 w.

13382. Sorting Ores for Shipment (M S R–June 1.) 8000 w.

†13395. A New Method of Reducing Metallic Oxides. William H. Greene and William H. Wahl (J F I–June.) 2200 w.

*13409. The Action of Cyanide of Potassium on Gold and Some Other Metals and Minerals. (Abstract.) A. Goyder (A M S–April 22.) 600 w.

*13412. Gold Saving without Water (A M S–April 22.) 800 w.

13443. Cupolas. — Their Construction and Management. W. J. Keep (Ir Age–June 8.) 2000 w.

13445. The Iron Industry of New York and New Jersey (Ir Age–June 8.) 850 w.

†13466. Heating and Working of Metals by Electricity. Ill. George D. Burton (T Q–Dec.) 2400 w.

Serials.

9459. The Manufacture of Coke. Ill. John Fulton (C E–Began Jan.—6 parts to date—30 cts. each).

10275. The Analysis of Iron and Steel. J. Parry and J. J. Morgan (I L–Began Jan 27—7 parts to date—30 cts. each).

12159. Technical Education for the Molder. S. Bolland (F D–Began April 10—2 parts to date—15 cts. each).

12195 Molding by Machinery, Foundry Appliances, etc. Ill. S. Bolland (A M–Began April 20—3 parts to date—15 cts. each).

12206. The Sulphide Question (A M S–Began March 18—2 parts to date—30 cts. each).

12458. The Effects of Alloys on the Mechanical and Physical Properties of Metals. W. C. Roberts-Austen (I–Began April 21—3 parts to date—30 cts. each).

12714 The Practical Zinc Worker. Ill. W. J. Eden-Crane (Pl D–Began May 1—1 part to date—30 cts).

12794. A Review of the Russell Process. L. D. Godshal (M I T–Began May 11—Ended May 18—2 parts—15 cts. each).

12845. The Adaptation of Hydraulic Power in the Manufacture of Iron and Steel. James L. Biggart (I C T–Began May 5—1 part to date—30 cts).

12868. Present Condition of the Mechanical Preparation of Ores in Saxony, Hartz, and Rhenish Prussia. Ill. M. Maurice Bellom (S M Q–Began April—1 part to date—45 cts).

12897. Iron and Steel at the World's Columbian Exposition. E. C. Potter (Ir Age—Began May 18—2 parts to date—15 cts. each).

12938. Variations of the Coefficient of Friction with Different Loads and Bearing Metals. Ill. Joseph Kuhn and Robert T. Mickle (E N–Began May 18—Ended May 25—2 parts—15 cts. each).

13117. The Thomas Process in Belgium (A M & I W–Began May 26—1 part to date—15 cts).

13441. Artistic Wrought Iron. Ill. (Ir Age–Began June 8—1 part to date—15 cts).

13473. Variations in the Milling of Gold Ores.—The Ovens, Victoria. T. A. Rickard (E M J–Began June 10—1 part to date—15 cts).

MILITARY ENGINEERING.

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†12953. Theoretical Discussion of the Brown Segmental System of Wire Gun Construction. Ill. G. N. Whistler (J U S A–April.) 16000 w.

*12978. The Giffard Gun. Ill. (I–May 12.) 700 w.

*12999. Electricity in the Navy. Editorial (Inv–May 13.) 1200 w.

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*13063. A New Automatic Magazine Rifle (M–May 15) 850 w.

13070. The Best All-Round Modern Ship (Sc A S–May 27.) 1000 w.

*13130. Italian Naval Progress. Editorial (Eng L–May 19.) 1500 w.

*13171. H. M. S. "Speedy" (E–May 19) 3000 w.

*13173. The Power Trials of H. M. Battleship "Ramillies" (E–May 19.) 1000 w.

13205. The New York, the Fastest Cruiser (B I S–May 31.) 1100 w.

†13228. The Lesson of the Naval Review. Hilary A. Herbert (N A R–June.) 3000 w.

*13253. The Merrimac and the Cumberland. Ill. Thomas O. Selfridge, Jr. (Cos–June.) 5800 w.

*13368. Naval Engine-Room Efficiency. Editorial (E–May 26.) 2000 w.

13424. Machinery of the New Composite Gun-boats (A M–June 8.) 2400 w.

13448. Rams in Naval Warfare, with Editorial. Daniel Ammen (Sea–June 8.) 1800 w.

†13463 The New Tactics. H. L. Hawthorne (T Q–Dec.) 6000 w.

13485. Invisible Torpedo Boats (M N–June 1.) 1700 w.

Serials.

10431. Field Artillery Draft. A. E. Schenck (J U S A–Began Jan.—Ended April—2 parts—45 cts. each).

10738. The Development of American Armor-Plate. Ill. F. Lynwood Garrison (M–Began Feb. 15—4 parts to date—30 cts. each).

MINING.

*12688. Coke Manufacture in the United States. Ill. W. G. Wilkins (E Mag–July.) 4000 w.

12725. A History of the Miners' Movement. Editorial (M S P–May 6.) 850 w.

12726. The Caminetti Law—An Act to Create the California Debris Commission and Regulate Hydraulic Mining in the State of California (M S P–May 6.) 3000 w.

12727. Full Text of the North Bloomfield Decision (M S P–May 6.) 4000 w.

12728. The Ford Hydraulic Mining Law (M S P–May 6.) 1800 w.

12765. An Electric Mining Plant at Bodie, Cal. Ill. (E M J–May 13) 700 w.

12766. The Indiana Natural Gas Field. Ill. C. R. Boyd (E M J–May 13.) 1400 w.

12793. Ore Sorting and Sampling. Ill. (M I T–May 11.) 1200 w.

*12797. A Welsh Colliery Exhibit at Chicago. Ill. (E–May 5.) 1900 w.

*12814. Tests in Collieries with the Chesneau Fire-damp Indicator. M. G. Chesneau (C G–May 5.) 4000 w.

*12815. The Use of Safe Explosives in Coal Mines. Edwin Gilpin (C G–May 5.) 4100 w.

*12816. The Mines (Eight Hour) Bill (C G–May 5.) 2000 w.

*12846. The Nationalization of Minerals. Editorial (I C T–May 5.) 900 w.

*12849. Belgian Iron and Coal in 1892. Victor Watteyne (I–May 5.) 1200 w.

†12875. Historical Notes Bearing upon the Work of the First Mining Engineer of the Colony of Virginia. William H. Adams (T A E V–March.) 5000 w.

*12892. The Opening Speeches of the Australian Institute of Mining Engineers (A M S–April 15.) 3400 w.

12915. Famous Gold Nuggets (Sc A S–May 20.) 550 w.

12928. South Carolina's Resources (M R–May 19.) 1100 w.

12940. The Warwhoop Bauxite Bank, Alabama. W. M. Brewer (E M J–May 20.) 800 w.

12948. The Bent and Hartwell Calliope Mining Swindle (M I T–May 18.) 2000 w.

12957. Syndicating Coal Industries. Editorial (A S–May 20.) 500 w.

12973. The World's Petroleum Supply (A M & I W–May 19.) 1300 w.

*12988. Practical Instructions for Using the Chesneau Fire-damp Indicator. Ill. (C G–May 12.) 3600 w.

*12989. Safety Net at the Blanzy Colliery, France. M. Lebreton (C G–May 12.) 900 w.

*13000. Mining and Ore Treatment at Broken Hill (I C T–May 12.) 1600 w.

13097. Some Alabama Gold Mining Districts. W. M. Brewer (E M J–May 27.) 1900 w.

13098. Mining at the Columbian Exposition. Ill. (E M J–May 27.) 3300 w.

13120. "Big Injun" Oil Sand. Edward Orton (A M & I W–May 26.) 1500 w.

*13153. The North Staffordshire Coalfield. M. E. (C G–May 19.) 2200 w.

*13157. The Big Stone Gap Coalfield. James M. Hodge (C G–May 19) 3500 w.

*13179. Coalfields in China (I L–May 19.) 1300 w.

*13187. The Oil Wells of Upper Assam (I & S–May 20) 1100 w.

13217. The Indiana Gas Belt. C. R. Boyd (Ir Age–June 1.) 1400 w.

13224. The Mines of the Mary Lee Coal & Railway Co. (M R–June 2.) 1400 w.

13254. The Alabama Gold Fields. William M. Brewer (T–June 1) 1200 w.

13256. Minerals in the Russian Caucasus (E M J–June 3.) 500 w.

13257. The Ultimate Composition of Some Alabama Coals and Coke. William B. Phillips (E M J–June 3) 400 w.

13258. The Copper Mines of Arizona (E M J–June 3.) 800 w.

*13303. Testing Stations for Explosives at the Produits Collieries, Flenu, Belgium. Ill. A. Macquet (C G–May 26.) 4000 w.

*13308. The Rhenish-Westphalian Coal Syndicate (C G–May 26.) 2000 w.

*13323. A Practical Talk with Miners—Precautions to be Used in Firing Shots in Dusty Mines. J. T. Beard (C E–June.) 2000 w.

*13324. Cost of Mining Coal. Editorial (C E–June.) 1000 w.

*13325. The Anthracite Coal Needle. Ill. (C E–June.) 500 w.

*13327. On Metal Mining.—A Description of the Overhand Stoping Method. Ill. (C E–June.) 1000 w.

13429. Coal of the World (M & B–May.) 2000 w.

13436. New Hydrogen Miner's Safety Lamp (Abstract). F. Clowes (Sc A S–June 10.) 700 w.

*13447. The Hydraulic Mining Problem (I S F–June.) 1350 w.

13481. Petroleum and its Uses (M G–June 10.) 2000 w.

Serials.

11282. Mine Ventilation Made Easy. Ill. W. Fairley (C E—Began March—4 parts to date—30 cts. each).

11574. The Mineral Resources of the Southern States (I L—Began March 17—Ended May 5—3 parts—30 cts. each).

11801. Information to Aid in the Search for Gold and Silver. Ill. Arthur C. Lakes (C E—Began April—3 parts to date—30 cts. each).

11804. Fire-Damp. H. LeChatelier. Translated by H. H. Stock (C E—Began April—3 parts to date—30 cts. each).

12205. Tin Deposits, Brookstead Estate, Tasmania (A M S—Began March 18—2 parts to date—30 cts. each).

12450. The Coal Fields of Canada. William Hamilton Merritt (C E—Began May—2 parts to date—30 cts. each).

12767. Reports of the Mine Inspectors of Pennsylvania for 1892 (E M J—Began May 13—Ended May 20—2 parts—15 cts. each).

12891. Origin and Distribution of Gold and Platinum, N. Coast Beaches, N. S. W. J. W. Archibald (A M S—Began April 8—2 parts to date—30 cts. each).

13315. The Petroleum Industry of Austria-Hungary. Arthur W. Eastlake (I L—Began May 26—1 part to date—30 cts).

13410. West Australia Mineral Fields (A M S—Began April 22—1 part to date—30 cts).

13474. Waste in Anthracite Coal Mining (E M J—Began June 10—1 part to date—15 cts).

RAILROADING.

*12689. The Safety Car-Coupler Problem. W. M. Mitchell (E Mag—July.) 2500 w.

12719. Locomotives of 1831 and 1893. Ill. (Sc A—May 13.) 900 w.

12729. Official Report of the New York Central Brake Tests at Karner, N. Y. (R G—May 12.) 5000 w.

12730. Reynolds' Automatic Crossing Gate. Ill. (R G—May 12.) 750 w.

12731. The West Albany Brake Trials (R G—May 12.) 2200 w.

†12739. Some Data on Rail-Joints, with Discussion and Tables. Lucien Scaife (E S W P—Vol. VIII.) 900 w.

12751. The Mozier Three-Position Semaphore and Safety Signal. Ill. (E N—May 11.) 2300 w.

12753. Four-Cylinder Compound Locomotive, Hungarian State Railway. Ill. (E N—May 11.) 1000 w.

*12817. Railway "Return Circuits." J. F. E. (S R R—May.) 1700 w.

*12818. A Few Sample Transfers (S R R—May.) 700 w.

*12819. Chicago Cables Cross. Ill. (S R R—May.) 600 w.

12837. Unremunerative Transportation Rates, with Editorial (R R—May 13.) 1500 w.

12838. Contract Rights of Corporations (R R—May 13.) 1350 w.

12839. Stock Watering. George B. Crocker (R R—May 13.) 3000 w.

12840. Delays to Freight in Yards (R R—May 13.) 2700 w.

*12842. The French Railways in the Halls of Liberty (Tr—May 5.) 1100 w.

12855. State Taxation of Street Railway Companies in Pennsylvania. Homer Shoemaker (E R N Y—May 20.) 850 w.

†12872. Easement Curves. C. H. Rice (T A E V—March.) 3000 w.

†12873. Establishing a School for Young Men to Fit Themselves to be Railroad Men, or a National Railroad School. Hermann Crueger (T A E V—March.) 3000 w.

†12876. Locomotive Tests. G. R. Henderson (T A E V—March.) 2200 w.

12902. The Railroad Across the Andes in South America (M N—May 15.) 1400 w.

12904. Endless Steel Rails (M N—May 15.) 250 w.

†12925. Note on the Inspection of the Bezvada-Godavari Section of the East Coast Railway by the Government Inspector, Prior to Opening. W. V. Constable (I E—April 15.) 2200 w.

12931. The Boom in Street Rails (B I S—May 17.) 700 w.

12933. The Great Northern Railway Tunnel Through the Cascade Mts. Ill. (E N—May 18.) 600 w.

12934 The Baltimore Belt Railroad Tunnel. Ill. (E N—May 18.) 1500 w.

12942. Railway Balance Sheets. An Auditor (R G—May 19) 1100 w.

12943. A Compromise System of Live Loads for Dimensioning Bridges (R G—May 19.) 1000 w.

12944. Standard Trucks and Foundation Brake Rigging (R G—May 19.) 2500 w.

12945. The "Rocket" at the Rainhill Trials. Ill. W. W. Acworth (R G—May 19.) 4500 w.

12946. Uniformity of Air Brakes and the Breaking-in-Two of Trains. Editorial (R G—May 19.) 1000 w.

12947. The Park Avenue Improvement, New York (R G—May 19.) 900 w.

12952. Street Railway Franchises. R. D. Fisher (S R G—May 20.) 2500 w.

12955. The Education of Roadway Foremen. Julien A. Hall (R R—May 20.) 1000 w.

12956. Protection that Does not Protect. Editorial (R R—May 20.) 1000 w.

*12994. Wastefulness and Bungling in Australian Railways. Editorial (Tr—May 12.) 700 w.

12997. Locomotives at the World's Fair (R A—May 19.) 600 w.

13007. The Union Station and Passenger Terminals for the Northern Railroads of the City of Boston. Editorial (E R—May 20.) 1000 w.

*13014. Overhead Wiring for Small Towns. E. H. T. (E E L–May 12.) 900 w.

*13015. The Lighting of Railroad Trains. Ill. Oswald Haes (E E L–May 12.) 3700 w.

*13021. The Analysis of Engine Tests. Editorial (Eng L–May 12.) 1800 w.

*13023. The Interlocking of Signal Levers and Block Instruments. Ill. Zed (E–May 12.) 3000 w.

*13024. Automatic Block Signalling (E–May 12.) 2000 w.

13043. An Automatic Safety Switch.—Hutchin's Invention. Ill. (E R N Y–May 27.) 1400 w.

13067. The Electric Railway between Chicago and St. Louis. Ill. (Sc A–May 27.) 1400 w.

13079 The Quaker City and Northeastern Elevated Railways, Philadelphia, Pa. Ill. (E N–May 25.) 750 w.

13080. Four-Track Steel Viaduct in New York City, New York Central and Hudson River R. R. Ill. (E N–May 25.) 2500 w.

13085. The Rapid Transit Problem in New York. Editorial (E N–May 25.) 900 w.

13086. The Railway Accident at Lafayette, Ind. (E N–May 25.) 2500 w.

13096. The Terminal Reorganization (M R–May 26.) 1550 w.

13107. The Johnson Signals in the Fourth Avenue Tunnel, New York. Ill. Arthur H. Johnson (R G–May 26.) 2000 w.

13109. Wattson and Stewart's Automatic Block Signal System for Tunnels (R G–May 26.) 800 w.

13110. World's Fair Travel. Editorial (R G–May 26) 2100 w.

13111. A Suggested Economy in Freight Car Repairs. Editorial (R G–May 26.) 1000 w.

13121. Origin and Administration of the Interstate Commerce Law. James A. Logan (R R–May 27.) 3300 w.

13124. New York and Chicago Car Service (R A–May 26.) 800 w.

13125. A Night Ride Down the Andes. J. Orton Kerbey (R A–May 26.) 2500 w.

13126. A Standard Freight Truck.—The Possibility of Adopting One and the Difficulties in the Way (R A–May 26.) 2000 w.

*13132. The Boyer Railway Speed Recorder. Ill. (Eng L–May 19.) 800 w.

*13143. Light Railways at Mines. Walter J. May (Inv–May 20.) 800 w.

*13156. Tests of Railway Iron in France. M. Mussy (C G–May 19.) 2200 w.

*13166. Effect of Earthquakes on Northwestern Railway, India. Ill. (E–May 19.) 600 w.

13213. Bellefontaine Railway, St. Louis. Ill. (S R G–May 27.) 1700 w.

*13219. The Empire State Express Locomotive.—No. 999. Ill. (N C B–June.) 2000 w.

*13220. Inside Finish of Passenger Cars. Robert M'Keon (N C B–June.) 1200 w.

*13221. Boiler Explosions on the Reading (N C B–June.) 2700 w.

*13222. The Austrian Royal Train. Ill. (N C B–June.) 700 w.

13234. The Broad Street Station Train Shed; Pennsylvania R. R., Philadelphia. Ill (E N–June 1.) 2000 w.

13241. A Compromise System of Live Loads for Designing Railway Bridges (E N–June 1.) 900 w.

*13245. The Locomotive "James Toleman." Ill. (L E–June.) 700 w.

*13246. An Exciting Night on a Confederate Soldier Train. C. S. Anderson (L E–June.) 1700 w.

*13247. Making Locomotive Engineers—Two Processes. J. J. Clair (L E–June.) 2500 w.

13249. An Ancient Traveler—The "John Bull." Ill. William Morris Hayes (I Age–June.) 1000 w.

*13274. Electric Accumulator Traction at Birmingham. Ill. (R W–May.) 3000 w.

*13275. Some Features of the Swindon Locomotive Works. Ill. (R W–May.) 4000 w.

*13276. The London Tramway Company's Cable Road (R W–May.) 2300 w.

13277. High Speed Electric Traction—Letters from Frank B. Lea and Albion T. Snell (R G–June 2.) 1800 w.

13278. The 20-Hour Trains Between New York and Chicago. (R G–June 2.) 2500 w.

13279. The Lafayette Accident. Editorial (R G–June 2.) 2600 w.

*13289. Ordinary Types of Belginm State Railway Locomotives. Ill. G. Brack (A E R J–June.) 4800 w.

*13314 Types of Locomotive Used on the Japanese Railways. Ill. (I L–May 26.) 1000 w.

*13338. A Peculiar Instance of Grade Reduction. F. K. Vial (Tech–No. 7.) 1800 w.

*13341. Equivalent Circular Curves for Railroad Turnouts. R. C. Vial (Tech–No. 7.) 1000 w.

*13347. Cheap Traction or Defective Telephones (E R L–May 26.) 1500 w.

†13371. The Murren Cable Incline and Electric Mountain Railway. Ill. (S R J–June.) 1900 w.

†13372. San Francisco, Cal.—The Birthplace of the Cable Railway. Ill. C. B. F. (S R J–June.) 2200 w.

†13373. The Wheless Electric Railway Company's Conduit and Aerial Trolley System. Ill. A. L. Register (S R J–June.) 2000 w.

13384. Discrimination by Railways. Martin C. Knapp (R R–June 3.) 2200 w.

13385. The Lighting of Railway Trains. Ill. Harry Pollitt and L. R. Manchester (R R–June 3.) 2800 w.

13387. Turning Railway Switches by Electricity. Ill. (R R–June 3.) 1200 w.

13388. The Personal Element in Railway Operation (R R–June 3.) 600 w.

13389. Tons and Revenue not Synonymous Terms (R R–June 3.) 1400 w.

13390. The Extent to which Railroad Companies Must Provide for Their Employés' Safety (R R–June 3.) 1800 w.

13400. Tests of Street Railway Return Circuits. Lucius T. Gibbs (E W–June 10.) 1000 w.

13432. Application of Electric Propulsion by Accumulators to the Tramways of Paris (Sc A–June 10.) 1000 w.

13450. Harvey Steel Cars. Ill. (E N–June 8.) 700 w.

13452. The Record of Janney Coupler Breakages. Ill. (E N–June 8.) 800 w.

13457. Amendments to the Interchange Rules (E N–June 8.) 1300 w.

13459. Some Automatic Brake Slack Adjusters. Ill. (E N–June 8.) 900 w.

13475. The Coupler Tests of the Western Railway Club. Ill. (R G–June 9.) 2500 w.

13476. Standard Trucks and Frames for Freight Cars. Editorial (R G–June 9) 1800 w.

Serials.

9254. Railway Management. Horace Cope. (R R–Began Dec. 31—6 parts to date—15 cts. each).

11962. The History of the South Eastern Railway. G. A. Sekon (R P L–Began April—2 parts to date—30 cts. each).

11974. Railroad Management, Past, Present, and Prospective Quintin McNab (R R–Began April 8—2 parts to date—15 cts. each).

12001. Rails on the Creep. Ill. A. Ewbank (I E–Began March 11—7 parts to date—45 cts. each).

12527. Patenall's Improved Sykes System of Block Signals. Ill. (A E R J–Began May—2 parts to date—30 cts each).

12614. Railway Stations Ill. Leon Benonville (A A–Began May 6—2 parts to date—15 cts. each).

12984. Some Notes on the Design of Series Motors for Traction. Ill. J. Douglas Dallas (E R L–Began May 12—Ended May 26—2 parts—30 cts. each).

SANITARY ENGINEERING.

*12713. Ideal Drainage. Editorial (Pl D–May 1.) 1100 w.

12749. The London "Lancet" on Chicago's Water Supply and Sewage Disposal Systems. Ill. (E N–May 11.) 3200 w.

12792. The Lake Union Sewer Tunnel, Seattle, Wash. Ill. (E R–May 13.) 1200 w.

*12811. Margate-Sewerage Works.—Hydraulic Sewage Pumps. Ill. (Eng L–May 5.) 2000 w.

†12877. Heating and Ventilation. R. P. C. Sanderson (T A E V–March.) 3500 w.

†12880. Flood Waves in Sewers.—Continued Discussion. Arthur N. Talbot and Alva J Grover (T C E–March.) 1700 w.

12964. The Sewerage of Charlottetown, P. E. I. George E. Waring, Jr. (A A–May 20.) 2800 w.

13008. Recent Municipal Work in Omaha. Ill. (E R–May 20.) 1600 w.

13081. The Old Metropolitan Sanitary District of New York, 1866 to 1870 (E N–May 25.) 450 w.

13106. Ventilation (A A–May 27.) 1600 w.

13116. Method of Making a Sanitary Investigation of a River (Sc–May 26.) 1800 w.

13122. The Ventilation and Heating of Schools. Fred P. Smith (A Ar–May 27.) 2500 w.

13136. Sewage Pumping at Leicester, England (E R–May 27.) 2000 w.

*13196. Cleaning Asphalt Pavements.—A Short Chapter on Tools and Methods (G R–May.) 2000 w.

13212. The School-Room and the Health of the Children (S A–June.) 600 w.

13239 A Day on the Chicago Drainage Canal. Ill. (E N–June 1.) 3200 w.

13244 The Lasting Character of Soil Pollution (E N–June 1.) 1500 w.

13296. The Heating and Ventilation of Halls and Theaters by the Blower System. Ill. Walter B. Snow (Met W–June 3.) 2500 w.

*13340. Heating and Ventilation of Residences. James R. Willett (Tech–No. 7.) 5500 w.

13350. Some Foreign Methods of Air Moistening and Ventilation. Ill. (E R–June 3.) 800 w.

13379. Disinfectants and Disinfection. David Bevan (Sc–June 2.) 1500 w.

13486. The Collection and Disposal of Garbage. Editorial (M R–June 9.) 700 w.

Serials.

5358. Sewage Purification in America. Ill. (E N–Began July 14, 1892—26 parts to date—15 cts. each).

10425. A Healthy Home. Francis Vacher (S R–Began Feb. 1—8 parts to date—30 cts. each).

12628. Heating and Ventilation of Residences. Ill. James R. Willett (I A–Began April—2 parts to date—45 cts. each).

12780. The Heating Contractor. Leicester Allen (D E–Began May 13—1 part to date—15 cts).

13100. Plumbing. John Honeyman (A & B–Began May 27–Ended June 10—2 parts—15 cts. each).

13290. Sewage Disposal. J. Foster Flagg (P–Began June—1 part to date—30 cts).

STEAM ENGINEERING.

*12690. Steam Locomotion on Common Roads. William Fletcher (E Mag–July.) 3000 w.

12693. Boiler Furnaces for Burning Straw. George G. Smith (S E–April 29.) 600 w.

*12698. Note on the Reactive Influence of Steam. W. J. Millar (S I.–May.) 1700 w.

12700. Steam vs. Water Power. Samuel Webber (Ir Age–May 11.) 1150 w.

*12711. Who Was Inventor of the Triple-Expansion Engine? (E G–May.) 800 w.

†12735. On Smoke, with Discussion. William Metcalf (E S W P–Vol. VIII.) 1900 w.

†12743. Report of the Committee on Smoke Prevention, with Discussion (E S W P–Vol VIII.) 9300 w.

12748. Tests of Non-conducting Coverings for Steam Pipes. Ill. R. C. Carpenter (E N–May 11.) 2200 w.

†12775. The Variation in Economy of the Steam Engine Due to Variation in Load. R. C. Carpenter (T A I E E–May.) 4500 w.

12776. Water Columns. W. H. Wakeman (M G–May 13.) 850 w.

12779. How to Fire a Boiler.—The Best Practice for Economy and Large Duty.—Paris, Texas (B J C–May 13.) 1600 w.

12784. Progress in Steam Engineering. Robert H. Thurston (Eng–May 13.) 2600 w.

*12813. Coppers for Fire Boxes. Editorial (Eng L–May 5.) 2500 w.

*12827. Steam Pipes. Messrs. Geipel and Kilgour (El–May 5) 500 w.

†12869. Steam Boiler Explosions. C. G. Cushman (T A E V–March.) 1200 w.

12896. The Allis Quadruple Expansion Engine at the World's Fair. Ill. (Ir Age–May 18.) 2200 w.

12908. The Use and Abuse of Stationary Steam Boilers. Millard F. Burgess (S M–May 15.) 1100 w.

12911. A Condenser Pattern. Ill. Joseph Horner (A M–May 18.) 1400 w.

12968. Trouble with a Blow-off Pipe. Ill. (B J C–May 20.) 600 w.

12969. About Economizers (B J C–May 20.) 700 w.

12970. About Lubrication (B J C–May 20.) 1200 w.

12971. Piston-Rod Packing (B J C–May 20.) 1000 w.

13045. The Slide Valve. Ill. William B. Austin (S E–May 13.) 2000 w.

†13060. The Baldwin Compound Locomotive. Ill. S. M. Vauclain (P E C P–April.) 3000 w.

*13064. A Speaking Whistle (S R E N–May.) 1000 w.

13068. The Genesis and Exodus of Steam. George H. Babcock (Sc A S–May 27.) 5000 w.

13077. An Important Consideration in the Design of Boilers with Curved-Back Heads. Ill. (Ir Age–May 25.) 1000 w.

13112. The Testing of Boilers. Abstract of paper by J. T. Milton (Eng–May 27.) 1400 w.

13161. A Simple Steam Trap. Ill. (B J C–May 27.) 750 w.

13162. Boiler Settings and Rapid Combustion. Lawrence Nordland (B J C–May 27.) 1500 w.

13163. Doubling Belts.—An Engineer's Argument in Favor of the Practice (B J C–May 27.) 800 w.

*13167. Boilers in the Navy. Ill. (E–May 19.) 14 0 w.

*13168. Steam Capstans and Windlasses. Ill. (E–May 19.) 1000 w.

*13174. The Cyclogram. Ill. (E–May 19.) 600 w.

*13183. Division of Steam Used Between Ends of Cylinder, in Hirn's Analysis. R. S. Hale (S J E–May.) 900 w.

*13185. Economy of a Non-Condensing Compound Engine. Ill. R. C. Carpenter (S J E–May.) 4800 w.

*13260. Grooving in Steam Boilers. Ill. Edward G. Hiller (P Eng–May 26.) 2000 w.

13297. Simple vs. Compound Locomotives, with Editorial. R. H. Thurston (R A–June 2.) 4000 w.

*13302. The Ejector Condenser. Ill. (Eng L–May 26.) 4500 w.

13352. Steam Plants on Upper Floors. Charles H. Fitch (S E–May 27.) 650 w.

13361. Taking Exhaust Steam from Engine Receivers. Ill. (B J C–June 3.) 1800 w.

13362. Scale in Boilers.—What It Shows About the Circulation of the Water. Paris, Texas (B J C–June 3.) 900 w.

13422. Errors in Indicator Reducing Gear. Ill. M. E. (A M–June 8.) 1500 w.

13462. Smoke Prevention. Olin A. Landreth (E N–June 8.) 3000 w.

†13467. Measurement of Steam by the Flow through an Orifice. Ill. E. F. Miller and C. A. Read (T Q–Dec.) 900 w.

13478. The Keene Explosion (B J C–June 10.) 500 w.

13479. Steam Ports and Pipes.—Their Proper Size for Compound Engines (B J C–June 10.) 1500 w.

Serials.

9817. The Injector. I. B. Rich (S M–Began Jan. 15—3 parts to date—15 cts. each).

11138. Notes on the Steam Injector. Ill. Strickland L. Kneass (E M–Began March—3 parts to date—30 cts. each).

11720. Steam Boilers. James F. Hobart (T–Began April 1—4 parts to date—15 cts. each).

12377. Steam Shovel Work. Ill. E. A. Hermann (E N–Began April 27—5 parts to date—15 cts. each).

13033. Practical Hints to Boilermakers and Tinplaters (M W–Began May 12—1 part to date—30 cts).

TELEPHONY AND TELEGRAPHY.

*12821. Telegraphic Communication in the West Indies. R. B. Anderson (E R L–May 5.) 4000 w.

12854. Telephone Progress in St. Louis (E R N Y–May 20.) 900 w.

12920. Modern Equipment of Telephone

Stations. Ill. W. H. Hyde (W E–May 20.) 1600 w.

*12980. Rental v. Telephonemeter (E R L–May 12.) 1200 w.

13042. Telephone Charges.—Sensation vs Facts (E R N Y–May 27.) 850 w.

†13074. A Cable to Port Blair (I E–April 22.) 2000 w.

†13465. Lightning and Strong Current Arresters as Used for the Telephone. Ill. I. H. Farnham (T Q–Dec) 4000 w.

Serials.

12861. Reminiscences of Early Telephone Days. F. E. Kinsman (E E N Y–Began May 17—Ended May 24—2 parts—15 cts. each).

MISCELLANEOUS.

*12691. The World's Fair International Engineering Congress. J. K. Freitag (E Mag–July.) 3000 w.

12702. To Workingmen. Is Labor a Curse? R. G. Horr (B I S–May 10.) 2000 w.

12732. The Southern Immigration Question. D. Allen Willey (M R–May 12) 1200 w.

12768. The Reform Club Tariff Bill, with Editorial (O P D R–May 15) 1500 w.

12782. Restoring the Columns in the Piazetta, Venice (A A–May 13.) 1800 w.

*12799. The Industrial Development of India. Editorial (E–May 5) 1700 w.

*12800. Phillip's Flying Machine. Ill. (E–May 5)

*12804. What is Technical Education? Editorial (I I.–May 5) 1300 w.

*12808. Liverpool Cold Storage and Ice Company, Limited. Ill (Eng L–May 5.) 1000 w.

†12866. Sketch of Sir Archibald Geikie. Ill. (P S M–June.) 4000 w.

*12883. The Canal System of Canada. Allan Ross Davis (Ch–June.) 9000 w.

12899. Evolution of the Bicycle. Ill. (Ir Age–May 18) 4000 w.

12909. Engineering Progress.—Address of Alfred E. Hunt (S M–May 15.) 1600 w.

12917. Erecting a Heating Apparatus. Helios (Met W–May 20.) 1600 w.

†12922. Madras Engineering College (I E–April 15.) 1400 w.

12930. Southern Advantages as Viewed by a Massachusetts Cotton Manufacturer. W. C. Lovering (M R–May 19) 1000 w.

12958. The Centralization of Industries. Editorial (A S–May 20.) 500 w.

*12993. A Sidelight on a Great Canal Scheme. Editorial (Tr–May 12.) 950 w.

*13022. The Spectroscope of the Alleghany Observatory. Ill. (E–May 12.) 4000 w.

*13026. The James Forrest Lectures. Editorial (E–May 12.) 2100 w.

*13027. The Royal Society Soiree (E–May 12.) 3000 w.

†13035. Grave Obstacles to Hawaiian Annexation. Thomas M. Cooley (F–June.) 8300 w.

†13036. China's View of Chinese Exclusion. Gilbert Reid (F–June.) 3600 w.

13071. The Manufacture of Bicycles. Ill. (Sc A S–May 27.) 4500 w.

13151. Technical Education in Europe. Ill. Frank C. Perkins (E W–June 3.) 1200 w.

*13164. The Columbian Exposition.. J. D. (E–May 19.) 9000 w.

*13184. A Suggestion in Aeronautics. A. P. Zahm (S J E–May.) 1400 w.

13204. The Discoverers of America. Gardiner G. Hubbard (Sc A S–June 3) 7500 w.

13225. After the Timber is Cut. Land Owner (M R–June 2) 1500 w.

†13230. A Look Ahead. Andrew Carnegie (N A R–June.) 12400 w.

13232. The Engineering Department of McGill University. Ill. (E N–June 1.) 2000 w.

13238. The Status of Engineers and a Proposed Plan for Improving It. Ernest McCullough (E N–June 1.) 1300 w.

*13252. The Rise and Decline of the Hawaiian Monarchy. Ill. Herbert H. Gowen (Cos–June.) 4800 w.

*13331. Brickmaking on South American Railways. P. Mogensen (Tech–No. 7.) 1600 w.

†13342. The Determination of the Relative Sensitiveness of Explosive Substances Through "Explosions by Influence." Charles E. Munroe (J A C S–Jan.) 1800 w.

*13355. Russian Industrial Art. E. A. Delmar-Morgan (B A–May 26.) 2800 w.

*13365. The Opening of the Columbian Exposition. J. D. (E–May 26) 5500 w.

*13366. The Extension of University College. Ill. (E–May 26) 7000 w.

*13370. Charges for Power at Jackson Park (E–May 26.) 2000 w.

*13381. The New Port of Tunis (Tr–May 26.) 1200 w.

*13383. Primitive Art in Egypt, with Discussion. W. M. Flinders Petrie (J S A–May 26.) 4300 w.

13396. Curves. Ill. F. H. Doane (E A–June 10.) 900 w.

13426. Harvesting India Rubber in South America (M & B–May.) 800 w.

13427. Luminous Paints. J. E. Smith (M & B–May.) 700 w.

13435. The World's Columbian Exposition. Ill. J. D. (Sc A S–June 10.) 8000 w.

†13464. Weights and Measures of the United States. T. C. Mendenhall (T Q–Dec.) 3000 w.

13477. Charges for Power at the World's Fair. Editorial (R G–June 9) 900 w.

Serials.

9401. World's Columbian Exposition (E N–Began Jan. 5—13 parts to date—15 cts each).

11978. Some of my Experiences as an Engineer on the Niger. John Parkin (E G–Began April—3 parts to date—30 cts. each).

12382. The Ideal Engineering School (E N-Began April 27—5 parts to date—15 cts. each.)

12477. Argentine (Eng L-Began April 21—Ended May 26—3 parts—30 cts. each).

12540. Early Engineering Reminiscences. George Escol Sellers (A M-Began May 4—Ended June 8—3 parts—15 cts each).

12695. Atomic and Molecular Motions. A. E. Dolbear (E N Y-Began May 10—3 parts to date—15 cts. each).

12812 The Interdependence of Abstract Science and Engineering William Anderson (Eng L-Began May 5—Ended May 12—2 parts—30 cts. each).

13186 Practical Designing. Ill. Gleeson White (B A-Began May 19—2 parts to date—30 cts. each).

13211. The Seven Ages of Art. E. G. Lind (S A-Began June—1 part to date—15 cts).

13408. Scraps from an Engineer's Note Book (A M S-Began April 22—1 part to date—30 cts).

NEW BOOKS OF THE MONTH.

[For the convenience of readers any American books will be supplied at publishers' prices by The Engineering Magazine Co. Foreign books, 25 per cent. extra.]

Baldwin Locomotive Works Exhibit at the World's Columbian Exposition. Philadelphia: Lippincott. [Cloth, 78 p.]

Bottone, S. R.=Electricity and Magnetism. London: Whittaker and Co. [8vo, cloth, 198 p., $1]

Carpentry for River and Garden. New York: Ward, Lock, Bowden & Co. [12mo, cloth, 250 p., 40 cts.]

Catalogue of City, Park and Sewer Castings, Road Rollers, Crushers, etc. Allegheny, Pa.: Thomas Carlin's Sons. [16 p. Free on application.]

Catalogue of Coal Mining Machines; Elevating and Conveying Machinery. Columbus, O.: The Jeffrey Manufacturing Co. [Paper, 96 p. Free on application.]

Cox, William.=The Slide Rule: Including Description and Method of Using the "Duplex" Slide Rule,—an improved form of the "Mannheim." Of Great Value to Mechanical and Civil Engineers. New York: Keuffel & Esser Co. [8vo. 44 p., 75 cts.]

Dibble, F. L.=Vagaries of Sanitary Science. Philadelphia: Lippincott. [8vo, cloth, 464 p., $2.]

Kendall, J. D.=The Iron Ores of Great Britain and Ireland.—Their mode of occurrence, age, and origin, and the methods of searching for and working them. London: Lockwood. [8vo, 424 p., 16s.]

Loney, S. L =Mechanics and Hydrostatics for Beginners. New York: Macmillan. [16mo, 304 p., cloth, $1.25.]

Low, David Allen, and Bevis, Alfred W.=A Manual of Machine-Drawing and Design. New York: Longmans, Green & Co. [8vo, 373 p., cloth, $2.50.]

Manual of Guard Duty, U. S. Army. New York: Army and Navy Journal. [32mo, boards, 78 p., 25 cts]

Manufacturers of the United States. New York: Manufacturers' Publishing Co. [4to., cloth, 1800 p., $10.]

Martin, Franklin H.=Electricity: Diseases of Women and Obstetrics. Chicago: The W. T. Keener Co. [8vo, cloth, 266 p., $2.]

Maycock, W. Perren =Electric Lighting and Power Distribution.—Part II. London: Whittaker & Co. [12mo, 320 p., paper, 2s. 6d.]

McKinney, W. M.=American and English Railroad Cases. A collection of all the railroad cases in the courts of last resort in America and England. Northport, N. Y.: E. Thompson Co. [8vo, sheep, 710 p., $4.50]

Mineral Industry (The);=Its Statistics, Technology, and Trade in the United States and Other Countries, from the Earliest Times to the End of 1892. Statistical Supplement of the Engineering and Mining Journal. One of the most important and valuable publications ever inaugurated. New York: Scientific Publishing Co. [8vo, 628 p., cloth, $2.50.]

Outerbridge, Alexander E.=The Modern Traveling Crane. Philadelphia: William Sellers & Co. [8vo, 11 p., free on application.]

Palmbery, Albert.=Treatise on Public Health and its Applications in Different European Countries—(England, France, Belgium, Germany, Anstria, Sweden, and Finland). New York: Macmillan. [8vo, cloth, 559 p., $5.]

Poor, H. V.=Poor's Manual of the Railroads of the United States for 1893. In which is incorporated Poor's "Directory of Railway Officials and Directors." New York: H. V. & H. W. Poor. [8vo, cloth, $6.]

Practical Hints on Joint-Wiping for Beginners in Plumbing. New York: David Williams. [8vo, paper, 45 p., 25 cents.]

Renwick, E. S.=Patentable Invention. Rochester: The Lawyers' Co-operative Publishing Co. [12mo, sheep, 170 p., $2.]

Report of Commission Appointed to Investigate the Waste of Coal Mining, with the View to the Utilizing of the Waste. Philadelphia: Allen, Lane & Scott. [8vo, paper, 153 p.]

Schaeberle, J. M.=Terrestrial Atmospheric Absorption of the Photographic Rays of Light. Sacramento: State Printing Office. [8vo, cloth, 89 p.]

Searles, James M.=Life and Times of a Civil Engineer. Supplemented by the True Theory of the Mississippi River. Cincinnati: Robert Clarke & Co. [8vo, paper, 139 p.]

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A E .....Architectural Era. *m.* $3. New York.
A E R J.Am. Eng. and Railroad Journal. m. $3. N.Y.
A G......Am. Geologist. m. $3.50. Minneapolis.
A G L J..Am. Gas Light Journal. *w.* $3. New York.
A H......Annals of Hygiene. m. $2 per year. Phila.
A J Phar.Am. Journal of Pharmacy. *m.* $3. Phila.
A J R A..Jour. R'y. Appliances. *m.* $2. New York.
A M .....American Machinist. *w.* $3. New York.
A M & I W.Am. Man. and Iron World. $4. Pittsburg.
Am A ...American Agriculturist. m. $1.50. N.Y.
Am G....American Gardening. *m.* $1. New York.
Am S....American Shipbuilder. *w.* $2. New York.
A & N J..Army and Navy Journal. *w.* $6. New York.
A & N R..Army and Navy Register. *w.* $3. Wash'ton.
A Rev....Architectural Review. *s-q.* $5. Boston.
A S .....Age of Steel, *w.* $3. St. Louis.
B B......Brick Builder. *m.* $2.50. Boston.
B C......Boston Commonwealth. *w.* $2.50. Boston.
B & D ...Builder and Dec. m. $2. Minneapolis.
B I S . ..Bul. Am. Iron and St. Asso. *w.* $4. Phila.
B J C ...Boston Jour. of Commerce. *w.* $3. Boston.
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C ...... .Compass. m. $1 per year. New York.
C A......Calif. Architect. m. $3. San Francisco.
Can A .. Canadian Architect. *m.* $2. Toronto.
C & B... Carpentry and Building. m. $1. New York.
C E .....Colliery Engineer. *m.* $2. Scranton, Pa.
C E N... Canadian Elec. News. *m.* $1. Toronto.
C Eng....Canadian Engineer. *m.* $1. Montreal.
Ch.......Chautauquan. *m.* $2. Meadville, Pa.
C M......Century Magazine. *m.* $4. New York.
Cos.... ..Cosmopolitan. *m.* $3 per year. New York.
D E......Domestic Engineering. *m.* $1. Chicago.
E A......Electrical Age. *w.* $3 per year. New York.
E E N Y..Electrical Engineer. *w.* $3. New York.
E I.......Electrical Industries. m. $3. Chicago.
E M......Engineering Mechanics. m. $2. Phila.
E Mag ...Engineering Magazine. *m.* $3. New York.
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E N......Engineering News. *w.* $5. New York.
Eng .....Engineer. *s-m.* $2 per year. New York.
E N Y....Electricity. *w.* $2.50. New York.
E R......Engineering Record. *w.* $5. New York.
E R N Y..Electrical Review. *w.* $3. New York
E S W P...Proc. Eng. So. of W. Pa. *m.* $7. Pittsburg.
E W......Electrical World. *w.* $3. New York.
F .. . . Forum. *m.* $5 per year. New York.
F D......The Foundry. m. $1. Detroit.
F W .....Fire and Water. *w.* $3. New York.
G & F....Garden and Forest. *w.* $4. New York.
G G M...Goldthwaite's Geograp. Mag. *m.* $2. N. Y.
G R .....Good Roads. m. $2 per year. New York.
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I Age....Inventive Age. *s-m.* $1. Washington.

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I S F.....Industry. *m.* $2 per year. San Francisco.
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J A .. ..Journal of Architecture. *m.* $2. Phila.
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J A E S..Jour. Assoc. Eng. Soc. *m.* $3. Chicago.
J F I.....Jour. Franklin Institute. *m* $5. Phila
J M S I..Jour. Milit. Service In. *b-m.* $4. New York.
J N E W.Jour. N. E. Waterworks As. *q.* $2. New London.
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J U S A..Jour. U. S. Artillery. *q.* $2.50. Ft. Monroe.
L E......Locomotive Engineering. *m.* $2. N. Y.
L Mag...Lippincott's Magazine. *m.* $3. Phila.
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Met W...Metal Worker. *w.* $2 per year. N. Y.
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R R L...The Railway Review. *w.* London.
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13779. "Is the Game Worth the Candle?" John Thomson (E N–June 22.) 3000 w.

†13907. The Old Time Water-Wheels of America, with Discussion. Ill. Joseph P. Frizell (T C E–April.) 5500 w.

†13909. Discussion on "The Effect of Tuberculation on the delivery of a 48-in. Water Main," by J. Duane (T C E–April.) 7000 w.

*14078. Egypt. Editorial (Eng L–June 23.) 2200 w.

14105. The Municipal Power, Light and Water-Works of Austin, Tex. Ill. (E R–July 1.) 2000 w.

*14130. Water-Meters for Municipal Purposes (J G L–June 27.) 2000 w.

†14138. Irrigation in Sind (I E–June 3.) 700 w.

*14148. Some Problems in Pumping Fluids. Ill. J. Richards (I S F–July.) 3500 w.

14156. The New Water-Works Pumping Station at Marlborough, Mass. Ill. (E N–July 6.) 500 w.

14159. Troy's New Water Supply (F W–July 8.) 800 w.

Serials.

12685. Development of Modern Steam Pump. Wm. M. Barr (E Mag–Began July—Ended Aug.—2 parts—30 cts. each).

13628. The Works of the East Jersey Water Co. for the Supply of Newark, N. J. (E N–Began June 15—2 parts to date—15 cts. each).

13702. Hydraulic Lifts. Robert Carey (M W–Began June 9—3 parts to date—30 cts. each).

INDUSTRIAL CHEMISTRY.

*13523. The Chemistry of Iron. J. Frank Corbett (Y B S E–1893.) 2000 w.

14136. Notes on Chemical Manufacturing in Russia. R. Bowman (Sc A S–July 8.) 2500 w.

Serials.

12603. Facts and Figures on Electrolytic Chlorine and Soda. Emile Andreoli (E R L–Began April 28—Ended June 2—4 parts—30 cts. each).

INDUSTRIAL SOCIOLOGY.

*13493. Labor Legislation in England. R. S. Viktorov (E Mag–Aug.) 4000 w.

*13494. The Unit of Value in All Trade. Edw. Atkinson (E Mag–Aug.) 5000 w.

†13497. The Eight-Hours' Day and the Unemployed. John Rae (C R–June) 9300 w.

*13543. Syndicated Production and Distribution of Commodities. Editorial (I L–June 2.) 1500 w.

*13564. Labor Questions in Australasia. Editorial (E–June 2.) 2500 w.

†13582. Six Hundred Years of English Poverty: A Study in the Fluctuations of the Purchasing Power of Wages. Gustav F. Steffen (N C–June.) 8500 w.

†13583. How to Attract Capital to the Land. Lord Vernon (N C–June.) 4800 w.

*13663. Profit Sharing Explained and Defended. Review of book by T. W. Bushill (J G L–June 6.) 2000 w.

13794. One Industrial Problem. A. B. Salom (I I G–June.) 1200 w.

13842. The Wages Outlook. Editorial (A M & I W–June 23.) 900 w.

†13936. How Distrust Stops Trade. Edward Atkinson (N A R–July.) 2000 w.

†13937. The Anti-Trust Campaign. Albion W. Tourgee (N A R–July.) 5500 w.

†13939. Should the Chinese be Excluded? R. G. Ingersoll and T. J. Geary (N A R–July.) 7500 w.

*14000. The Labor Question in India. Editorial (E–June 23.) 2000 w.

*14033. Domestic Service. From the Standpoint of the Employee. Lucy M. Salmon (Cos–July.) 5000 w.

*14042. What Shall be Done with the Indian? From the Indian's Point of View. Chauncey Yellow Robe (N P R–July.) 1000 w.

†14044. Hostility of Foreign to American Labor (C M–July.) 1500 w.

14100. A Railroad Example. Editorial (A S–July 1.) 700 w.

14184. Some Things Employés do not Share. Editorial (I T R–July 6.) 600 w.

14201. Aid for the Unemployed (B J C–July 8.) 1000 w.

*14025. Tests of Paving Brick (P–July.) 1500 w.

*14026. Street Paving in Australian Cities. George H. Wallace (P–July.) 1500 w.

*14027. Street Paving in Boston (P–July.) 1200 w.

14152. The North Ave. Masonry Arch Bridge, Baltimore, Md. Ill. (E N–July 6.) 2000 w.

14167. How to Stop Levee Breaks. A. W. Soule (M R–July 7.) 600 w.

14185. Moving Loads for Railway Bridges, with Editorial. J. A. L. Waddell (E R–July 8.) 3000 w.

Serials.

11182. The Nicaragua Canal (E–Began Feb. 24—Ended June 16—6 parts—30 cts. each).

13009. Strains in Beams and Girders. Ill. John Wright Seaver (E R–Began May 20—3 parts to date—15 cts each).

13194. Highway Bridges. Ill. John N. Ostrom (G R–Began May—2 parts to date—30 cts. each).

13420. The Sher Shah Bridge, over the River Chinab near Multan, Punjab. Ill. Francis J. E. Spring (I E–Began May 6—Ended May 13—2 parts—45 cts. each).

13772. The Road System of Union County. Ill. F. A. Dunham (G R–Began June—1 part to date—30 cts).

13773. The Birthplace of American Road Improvement. Ill. James Owen (G R–Began June—1 part to date—30 cts).

ELECTRICAL MISCELLANY.

*13491. Electricity in the Home and Office. F. A. C. Perrine (E Mag–Aug.) 3000 w.

*13496. The Power Plant at the World's Fair. Ill. W. S. Monroe (E Mag–Aug.) 4000 w.

*13511. Electricity in Agriculture. George D. Shepardson (Y B S E–1893.) 3000 w.

*13517. The Electrical Engineer and His Work. George D. Shepardson (Y B S E–1893.) 4800 w.

*13520. An Experiment in Electric Resonance. Ill. A. Zileny (Y B S E–1893.) 500 w.

*13538. Effects Produced by Using an Inductionless Shunt with a Choking Coil. Ill. Hugh Erat Harrison (El–June 2.) 1200 w.

*13539. Some Experiments on the Electro-chemical Equivalent of Zinc. James Erskine Murray (El–June 2.) 800 w.

*13550. Rotary Magnetic Fields. Ill. Alexander Russell (E R L–June 2.) 800 w.

*13565. The Control of Sparking in Short Air-Space Dynamos. Ill. (E–June 2.) 2300 w.

*13571. Prof. Kennedy's Report on Tests of Steam Dynamo at Thames Ditton, May 20, 1893 (E E L–June 2.) 900 w.

13586. The Outlook for Electrical Engineers. Editorial (E E N Y–June 14.) 1000 w.

13587. Electrical Engineering at the University of Nebraska. Ill. R. B. Owens (E E N Y–June.) 2000 w.

13589. Temperature Error in Electrical Instruments. W. M. Hill (E W–June 17.) 1200 w.

13609. The Edge of the Future. Unsolved Problems that Edison is Studying. E. J. Edwards (E A–June 17.) 1900 w.

13645. Electric Heating. Ill. W. S. Key (E N Y–June 14.) 1500 w.

*13673. The Tendency in Central Station Design. Editorial (I L–June 9.) 1200 w.

13686. The Earth as an Electrical Conductor. A. F. McKissick (Sc–June 16.) 700 w.

13701. Advances in Electric Heating (A G L J–June 19.) 1400 w.

*13707. An Automatic Switch for Transformers. Ill. (E E L–June 9.) 1200 w.

*13715. A Curious Transformer Experiment. Ill. Rankin Kennedy (E R L–June 9) 500 w.

*13717. The Advantage of High Tension in Distribution (E R L–June 9.) 900 w.

*13720. Dynamos, Alternators and Transformers—Review of book by Gisbert Kapp. A. T. S. (El–June 9.) 2000 w.

13735. Electrolytic Action of Heavy Currents on Water and Gas Pipes. Cromwell Galpin (E R N Y–June 24) 1200 w.

13736. Motors for Alternating Currents. Ill. F. H. Leonard, Jr. (M S R–June 15.) 1200 w.

13738. Lieut. Fiske's Depression Position Finder. Ill. (E E N Y–June 21.) 1500 w.

13739. A Simple Method of Calculating Joint Resistances. William C. Ramsdell (E E N Y–June 21.) 700 w.

13762. Effective Alternating Currents and Electromotive Forces. A. E. Kennelly (E W–June 24.) 700 w.

13767. Electrolysis in the Production of Silver. F. M. F. Cazin (E A–June 24.) 1000 w.

*13803. The Faure-Sellon-Volckman Patents in the French Courts. Ch. Haubtmann (El–June 16.) 1800 w.

*13804. Comparisons between the Different Systems of Distributing Electricity. H. Robinson (El–June 16.) 5000 w.

*13843. The Accumulator (Eng L–June 16.) 1800 w.

*13860. Multiplication of the Number of Periods of Linuvoidal Currents. Désiré Korda (E E L–June 16.) 800 w.

13861. A Study in Polarization. John Daniel (Sc–June 23.) 1500 w.

13883. Electric Heating (B C–June 24.) 1500 w.

13895. Otis Elevators Controlled by the Leonard Method, in the American Theatre. Ill. (E E N Y–June 28.) 900 w.

13896. Statistics of Fires Caused by Electric Currents. G. S. Boudinot (E E N Y–June 28.) 600 w.

13900. Electro-Chemical Effects Due to Magnetization. George Owen Squier (E R N Y–July 1.) 6300 w.

13901. Fundamental Laws in Electro-Dynamics. Ill. B. B. James (E W–July 1.) 2000 w.

13902. The Accumulator in Commercial Work. List Prepared by J. Stanford Brown (E W–July 1.)

*14004. Electric Crane on Southampton Quay. Ill. (I & I–June 23.) 1500 w.

*14009. The Trumpy Automatic Accumulator Regulator. Ill. (E R L–June 23.) 1200 w.

*14011. Electrical Oscillations of Low Frequency and their Resonance (E R L–June 23) 1200 w.

14015. Benson Bidwell and his Electrical Inventions. Ill. Charles Freeman (E W–July 8.) 1500 w.

*14046. Electricity at the World's Fair. Ill. J. R. Cravath (R of R-July.) 3000 w.

*14047. Two Giants of the Electric Age. Thomas A. Edison, by Charles D Lanier, and Sir William Thomson, Lord Kelvin, by J. Munro. Ill. (R of R–July.) 20000 w.

14052. Electricity as a Fire Hazard. C. J. H. Woodbury (M G–July 1.) 1200 w.

*14062. Electrical Communication between Light Vessels, Rock Stations, and the Mainland. John Rochford (E E L–June 23.) 1700 w.

*14075. Luminosity in Vacuum Tubes. Ill. E. C. Rimington (El–June 23.) 2200 w.

*14076. Instrument for Testing Primary Batteries. Ill. (El–June 23.) 700 w.

14114. Formulæ for Calculating the Diameter and Length of an Armature. Arranged from Gisbert Kapp's "Transmission of Energy" (E E N Y–July 5.) 1500 w.

14144. The Testing of Dynamos and Motors. Hazen Ritchie (C E N–July) 1000 w.

14168. Electrical Shop Equipments (E N Y –July 5.) 1800 w.

Serials.

11501. Theory of the Transformer. Ill. F. Bedell and A. C. Crehore (E W–Began March 25—5 parts to date—15 cts. each).

11560. Electricity as a Motive Power. Ill. Albion T. Snell (El–Began March 17—6 parts to date—30 cts. each).

12668. Non-Synchronous Alternating Current Motors. H. Behn-Eschenburg (E W–Began May 13—3 parts to date—15 cts. each).

13013. Alternate Current Transformer Design. Ill. R. W. Weekes (E E L–Began May 12—6 parts to date—30 cts. each).

13591. Long Distance Electric Transmission of Power. W. F. C. Harrison (E W–Began June 17—2 parts to date—15 cts. each).

13710. The Development of the Electrical Engineering Industry. R. Percy Sellon (E P–Began June—1 part to date—30 cts).

13800. Single Electro-Motor Working, with Editorial. Ill. Mr. Richter (E L–Began June 10—3 parts to date—30 cts. each).

MARINE ENGINEERING

13499. Types of Ocean Going Cargo Steamers. Ill. (M R C–June 8.) 450 w.

13500. Most Powerful Boat on the Lakes. Car Ferry Sante Marie. Ill. (M R C–June 8.) 500 w.

*13533. The New Route to the Continent (Tr–June 2.) 800 w.

13704. The Pacific Coast Trade. Editorial (M Rec–June 15.) 1400 w.

13732. The Trinidad Line's New Steamship "Creole Prince." Ill. (Am S–June 22.) 600 w.

13741. The Work of the New York Dock Department (R G–June 16.) 1800 w.

13745. The Viking Ship for the Columbian Exposition, with Editorial. Ill. (Sc A–June 24.) 1100 w.

13747. The New Port of Tunis. Ill. (Sc A S–June 24.) 2000 w.

13766. Four Days Across the Atlantic. Editorial (Ir Age–June 22.) 900 w.

†13768. Caught on a Lee Shore. Pleasures and Perils of a Cruise on the Florida Coast. Ill. William Henn (C M–June.) 9000 w.

13781. Shipbuilding on the Coast of the Pacific. G. W. Dickie (Sea–June 22.) 2000 w.

13782. Angry Towboatmen. Regarding Lights Carried on Mastless Vessels (Sea–June 22.) 3000 w.

*13812. The Life of the Merchant Sailor. Ill. W. Clark Russell (Sc M–July.) 7000 w.

13918 Visit to the Viking Ship (Am S–June 29) 500 w.

13927. The Boatmen's Fight.—Safe Lights on Mastless Vessels in Tow Their Only Contention (Sea–June 29.) 2500 w.

13928 Fishing Banks' Boats. Ill. (Sea–June 29.) 1200 w.

13929. Steam Yachts.—Floating Palaces for our Millionaires (Sea–June 29.) 900 w.

†13941. International Yachting in 1893. George A. Stewart (N A R–July.) 3200 w.

*14001. The Possibilities of Speed on the Atlantic. Editorial (E–June 23.) 1800 w.

*14064. The Liverpool of the East. A Policy of Despair (Tr–June 23.) 1800 w.

14101. Petroleum in Marine Locomotion (A S–July 1.) 700 w.

14104. Deep-Water Harbors on the Texas Coast. Editorial (E R–July 1.) 600 w.

*14112. The Lubrication of Marine Engines. W. M. Ross (A E R J–July.) 1500 w.

14183. The Navahoe. Ill. (M Rec–July 6.) 900 w.

14196. Waterspouts at Sea.—Thrilling Experiences of Two Vessels (B J C–July 8.) 900 w.

*14203. Broken Propeller Shafts. Editorial (I & I–June 30.) 900 w.

Serials.

12250. Capt. Alexander McDougall's Patents. Ill. (M R C–Began April 20—9 parts to date—15 cts. each).

12961 Steel Ship Construction (M R C–Began May 18—3 parts to date—15 cts. each).

13393. The Lubrication of Marine Engines (M W–Began May 26—Ended June 2—2 parts —30 cts. each).

13449. Our Flag at Sea. William W. Bates (Sea–Began June 8—3 parts to date—15 cts. each).

13917. The Development of the Steamship. Horace See (Am S–Began June 29—2 parts to date —15 cts. each).

MECHANICAL ENGINEERING.

13605. Molding a Condenser. Ill. Joseph Horner (A M–June 15.) 1900 w.

13783. Counter-Shafts. C. R. Tompkins (M N–June 15.) 1200 w.

13841. A Curious Exposition Incident.—Starting the Ferris Wheel. E. C. P. (A M & I W–June 23.) 700 w.

13869. Rope-Power Transmission.—The English and American Systems (B J C–June 24.) 2000 w.

13912. The Great Wheel at Chicago. Ill. (Sc A–July 1.) 1500 w.

13920. Die Sinking.—Using the Die Sinking Machine. B. F. Spalding (A M–June 29.) 2000 w.

13923. Estimating Cost of Special Machines (Ir Age–June 29.) 600 w.

*13972. Durability of Hollow Bolts. Editorial (L E–July.) 650 w.

14073. Hints on Pattern Making (C & B–July.) 1800 w.

14197. The Big Ferris Wheel (B J C–July 8.) 1000 w.

Serials.

11246. Mechanical Engineering Materials. Edward C. R. Marks (P Eng–Began March 3—6 parts to date—30 cts. each).

12142. On Machine Designing (M W–Began April 7—5 parts to date—30 cts. each).

13181. Machine Tools. A. C. Amos (I–Began May 19—Ended June 9—3 parts—30 cts. each).

METALLURGY.

13509. The Passing of Iron. William Forsyth (R A–June 9.) 2500 w.

*13522. The History of Pig Iron. Peter H. Christianson (Y B S E–1893.) 3300 w.

*13524. The Bessemer Process. Harry E. White (Y B S E–1893.) 1200 w.

*13528. On the Hardening of Steel. W. Metcalf and J. W. Langley (P Eng–June 2.) 1800 w.

*13529. The Determination of Chromium in Ferro-Chromium. William Galbraith (I–June 2.) 2000 w.

*13530. Methods of Determining Chromium with Notes on the Distribution of Chromium in British Irons. J. E. Stead (I–June 2.) 5500 w.

*13549. Electricity in Metallurgical Operations: Laboratory Furnaces. Ill. (E R L–June 2.) 900 w.

*13553. Discussion of Messrs. Stead's and Saniter's Papers on the Desulphurizing of Iron (C G–June 2.) 5800 w.

*13554. Notes on Puddling Iron, with Discussion. John Head (C G–June 2.) 4200 w.

*13555. The Northwest Hematite Trade (C G–June 2.) 1700 w.

*13579. The Development of the Use of Aluminium (Eng L–June 2.) 2500 w.

*13596. An Important Invention.—A Slag Steam Generator (A M S–April 29.) 1300 w.

*13597. The Junction Company's Smelters, Port Adelaide.—Treatment of Broken Hill Sulphides (A M S–April 29.) 1200 w.

13652. Some Alabama Iron Notes.—The Barton-McCormick Process for Magnetizing Hematite Ores (E M J–June 17.) 850 w.

*13659. Manufacture of Coke. Charles S. Preston (S J E–June.) 1400 w.

13685. Reverbatory Furnaces. Ill. John Pettigrew (F D–June.) 1700 w.

13722. The Iron Industry in Mexico. Ill. Joseph Parkes (A S–June 17.) 1000 w.

13723. Case-Hardening.—The Utility of the Process and Various Methods of Performing It. B. F. Spalding (A S–June 17.) 2000 w.

*13725. On Combustion in the Hearth of the Blast Furnace (I & S–June 10.) 1600 w.

*13726. The Influence of Cold on the Strength of Iron and Steel. E. Kuczera and Eugene Reinisch (I & S–June 10.) 700 w.

*13727. On the Comparative Longitudinal and Transverse Strength of Mild Steel. F. Kintzle (I & S–June 10.) 500 w.

*13728. On the Hardening of Steel (I & S–June 10.) 1800 w.

13737. Sampling Ores Without Use of Machinery. W. Glenn (M S R–June 15.) 2000 w.

13746. Where Tin Comes From (Sc A–June 24.) 1000 w.

13754. Working Magnetic Iron Sands (M S P–June 17.) 900 w.

13764. The Bertrand Process for Rust Proofing, Tinning and Enameling Iron (Ir Age–June 22.) 700 w.

*13805. American Silverwork, with Discussion. H. Townsend (J S A–June 16.) 5500 w.

13840. Blast Furnaces in the Western States (A M & I W–June 23.) 550 w.

*13846. Turning Steel Tires. Editorial (Eng L–June 23.) 1100 w.

*13851. The Precipitation of Tin by Zinc. A. Harpf (I & S–June 17.) 900 w.

*13852. A New Copper Smelting District in Germany. B. Kosmann (I & S–June 17.) 600 w.

*13878. Manganese in Steel (C G–June 16.) 1400 w.

13887. Ore Dressing by Hand in Germany. Maurice Bellom (M I T–June 22.) 1200 w.

13966. The Unexpected in the Foundry. Thomas D. West (I T R–June 29.) 1000 w.

13967. Development of the Foundry in America the Past Thirty Years. William Ferguson (I T R–June 29.) 1500 w.

13990. The Precious Metals in 1892. Arthur Raffalovich (E M J–July 1.) 1400 w.

*14002. The Hardening of Structural Steel (E–June 23.) 600 w.

14035. Iron Matte Smelting (M I T–June 29.) 700 w.

*14058. Washed Coal for Coke Making. Walter J. May (C G–June 23.) 2300 w.

*14059. The Forging of Steel (C G–June 23.) 900 w.

*14079. The Causes of Waster Castings (P Eng–June 23) 1300 w.

14126. Pitting and Corrosion of Iron. Joseph Torrey (A M–July 6.) 2000 w.

14155. Iron and Steel Plate Chimneys. Fred. W. Gordon (E N–July 6.) 1500 w.

14182. Improving the Metallic Value of Calcined Ironstone. Walter J. May (A M & I W–July 7.) 1000 w.

14192. The Cheapening of Steel.—The Industrial Revolution Brought About by Improved Processes (M G–July 8.) 950 w.

Serials.

9459. The Manufacture of Coke. Ill. John Fulton (C E–Began Jan.—7 parts to date—30 cts. each).

10275. The Analysis of Iron and Steel. J. Parry and J. J. Morgan (I L–Began Jan. 27—Ended June 9—8 parts—30 cts. each).

12714. The Practical Zinc Worker. Ill. W. J. Eden Crane (Pl D–Began May 1—2 parts to date—30 cts. each).

13117. The Thomas Process in Belgium. Ill. (A M & I W–Began May 26—Ended July 7—4 parts—15 cts. each).

13441. Artistic Wrought Iron. Ill. (Ir Age–Began June 8—5 parts to date—15 cts. each).

13473. Variations in the Milling of Gold Ores.—The Ovens, Victoria. T. A. Rickard (E M J–Began June 10—Ended June 17—2 parts—15 cts. each).

13510. Semet-Solvay and Otto Hoffmann Coke Ovens (A M & I W–Began June 9—Ended June 16—2 parts—15 cts. each).

13569. Practical Applications of Electricity to the Heating and Welding of Metals. W. H. Watkinson (E E L–Began June 2—Ended June 9—2 parts—30 cts. each).

13880. Aluminium.—Its Production, Properties and Uses (Inv–Began June 17—2 parts to date—30 cts. each).

14141. Late Improvements in Copper Smelting. Dr. Peters, Jr. (A M S–Began May 20—1 part to date—30 cts).

14180. The Effect of Impurities in Iron and Steel When Manufacturing Tin Plates. John Bromilow (A M & I W–Began July 7—1 part to date—15 cts).

14188. The Specific Heats of the Metals. Ill. J. W. Richards (J F I–Began July—1 part to date—45 cts).

MILITARY ENGINEERING.

†13498. A Conscript's View of the French Army. Hilaire Belloc (C R–June.) 3800 w.

13611. The War Ship "New York." Ill. (Sc A–June 17.) 800 w.

13616. The Torpedo-Boat Force of Foreign Navies (Ir Age–June 15.) 1000 w.

13619. The Main Battery of the New Battle Ships (Ir Age–June 15.) 900 w.

13642. The Battleship "Massachusetts," with Editorial (Sea–June 15.) 1700 w.

13748. Serpolet's Steam Artillery Wagon. Ill. (Sc A S–June 24.) 1000 w.

13784. Making War in the Air (M N–June 15.) 600 w.

*13802. Recent Progress in Naval Engineering. W. H. White (I C T–June 16.) 1600 w.

*13813. Personal Recollections of Two Visits to Gettysburg. A. H. Nickerson (Sc M–July.) 9000 w.

†13815. Present Development of Heavy Ordnance in the United States. Ill. W. H. Jacques (J F I–July.)

†13829. The Grand Army as a Pension Agency. C. McK. Leoser (F–July.) 4300 w.

†13830. Complete History of the Farnham Post Revolt. John J. Finn (F–July.) 4000 w.

†13834. The Army as a Military Training-School. Edmund Hudson (F–July.) 4500 w.

*13845. Armor Question Puzzles. Editorial (Eng L–June 16.) 1200 w.

*13871. The Krupp Pavilion at Jackson Park (E–June 16.) 3000 w.

*13873. The Fuel Supply in War Ships. Editorial (E–June 16.) 2500 w.

*13876. The New Torpedo Craft (E–June 16.) 2200 w.

13882. The People's Battle.—An Address Delivered on the Anniversary of the Battle of Bunker Hill. Edward E. Hale (B C–June 24.) 5000 w.

13911. Sinking of the British War-Ship, Victoria. Ill. (Sc A–July 1.) 800 w.

13916. The Waterways of Our Country and Their Use in Military Operations. W. T. Hildrup House (Sc A S–July 1.) 2800 w.

13930. A Typical Volunteer Artillery Regiment.—The First Light Artillery, Ohio, N. G. Ill. C. S. C. (A & N J–July 1.) 2000 w.

†13948. Military Sanitation in the 16th, 17th and 18th Centuries. Charles L. Heizmann (J M S I–July.) 11400 w.

†13949. Army Regulations. H. B. Moon (J M S I–July.) 3500 w.

†13950. Is the Three Battalion Organization the Best One for Us? F. H. Edmunds (J M S I–July.) 2200 w.

†13951. Company Papers. G. P. Cotton (J M S I–July.) 3400 w.

†13952. Remarks upon the Organization of the Armies of Europe. J. J. O'Connell (J M S I–July.) 5300 w.

†13953. Experience of the Past the Best Guide for the Future. J. G. C. Lee (J M S I–July.) 1800 w.

†13954. Drill. C. J. Crane (J M S I–July.) 4500 w.

†13955. Some Suggestions in Regard to Arms, etc. Cornelius Gardener (J M S I–July.) 3600 w.

†13958. The Training of Cavalry for Reconnaissance. H. L. Pilkington (J M S I–July. 8500 w.

†13959. Field Guns. J. E. W. Headlam (J M S I-July.) 1800 w.

13978. Practical Tests of Modern Warships. Editorial (E N-June 29.) 800 w.

14120. Automatic or Recoil Operated Guns. Ill. (I Age-July.) 800 w.

14143. Rams in Naval Warfare. Ill. Ira Harris (Sea-July 6.) 4000 w.

Serials.

9347. Notes on Lectures on Artillery in Coast Defense. A. C. Hansard (J M S I-Began Jan.—4 parts to date—45 cts. each).

13956. Military Criticism and Modern Tactics G. F. R. Henderson (J M S I-Began July—1 part to date—45 cts).

MINING.

*13488. The Leadville of To-day. Ill. A. F. Wuensch (E Mag-Aug.) 3000 w.

*13557. Coal Mining in Japan (C G-June 2.) 2000 w.

*13558. Spontaneous Combustion in Coal Mines. (Abstract.) Joel Settle (C G-June 2.) 1400 w.

*13559. Recent Developments of the Hamilton Coal Field. Robert Thomas Moore (C G-June 2.) 3800 w.

*13560. The Employment of Women and Children in Indian Mines (C G-June 2.) 2500 w.

*13595. Coal Wages and Labor. Editorial (A M S-April 29.) 800 w.

*13600. How I Discovered Mount Morgan. E. F. Morgan (A M S-May 6.) 1800 w.

*13601. The South Australian School of Mines and Industries (A M S-May 13.) 1400 w.

13618. The Waste of Anthracite. Editorial (Ir Age-June 15.) 1100 w.

13622. South African Gold Mines (M S P-June 10.) 1200 w.

13661. The Coal Measures of Tennessee. J. B. Killehrew (M R-June 16.) 2100 w.

13662. Asphalt Mines in Syria. Constantine Khouri (R & T-June.) 900 w.

*13678. Discussion of the paper of Mr. Joel Settle on "Spontaneous Combustion in Coal Mines" (C G-June 9.) 3500 w.

*13679. Fire Setting: The Art of Mining by Fire. Arthur L. Collins (C G-June 9.) 1000 w.

*13681. The Clyde Coal field (C G-June 9.) 1800 w.

*13699. Coal and Iron in Germany in 1892. Max Diezmann (I-June 9.) 2500 w.

*13721. Application of Electricity to the Development of "Dip" Workings, and to Other Purposes, at Loganlea Colliery (El-June 9.) 1200 w.

*13801. The Manometric Efficiency of Fans, with Discussion. G. M. Capell (I C T-June 16.) 3500 w.

13816. The Spring Valley Mortgage Case (E M J-June 24.) 1100 w.

13894. Were There Ever Any Great Open Fissures? Carl Wulsten (M S R-June 22.) 2000 w.

13935. A New Telemeter Target. Ill. (C-July.) 2000 w.

13969. The Florida Phosphate Trade for the Half Year. J. H. Jones (M R-June 30.) 1400 w.

13987. The Coosa Coal Field in Alabama. Ill. W. M. Brewer (E M J-July 1.) 1500 w.

13988. Manganese Production of the United States. R. A. F. Penrose, Jr. (E M J-July 1.) 1000 w.

13989. The Petroleum Industry of Austria-Hungary. Ill. Arthur W. Eastlake (E M J-July 1.) 900 w.

*14006. Our Annual Coal Waste: What It Means. Editorial (I & I-June 23.) 700 w.

14039. Bauxite Ores in the South. W. M. Brewer (T-July 1.) 1200 w.

*14084. Culm Deposited in Streams. Results in a Law Suit for $250,000 Damages (C E-July.) 1000 w.

*14085. The Utilization of Small Bituminous Coal. Editorial (C E-July.) 1400 w.

*14086. Some Facts Regarding Anthracite Coal. Editorial (C E-July.) 2000 w.

*14087. Anthracite Coal Waste. Report of the State Commissioner Appointed to Investigate the Subject (C E-July.) 1500 w.

*14089. Description of Veins and Ore Deposits. Ill. A. C. Lakes (C E-July.) 1000 w.

*14090. A Description of the "Underhand Stoping" Method of Working. Ill. M. C. Ihlseng (C E-July.) 500 w.

†14092. Notes on Some of the Iron-Bearing Rocks of the Adirondack Mountains. Frank L. Nason (A G-July.) 2200 w.

14135. The Utilization of Coal Mines. Prof. Blake (Sc A S-July 8.) 1400 w.

14174. "The Mining of Silver" and the Appreciation of Gold (E M J-July 8.) 2000 w.

14175. The Penobscot Mine and Mill, Montana. H. M. Beadle (E M J-July 8.) 1200 w.

Serials.

11282. Mine Ventilation Made Easy. Ill. W. Fairley (C E-Began March—5 parts to date—30 cts. each).

11801. Information to Aid in the Search for Gold and Silver. Ill. Arthur C. Lakes (C E-Began April—4 parts to date—30 cts. each).

11804. Fire-Damp. Ill. H. Le Chatelier Translated by H. H. Stoek (C E-Began April—4 parts to date—30 cts. each).

12450. The Coal Fields of Canada. Ill. Wm. Hamilton Merritt (C E-Began May—3 parts to date—30 cts. each)

12598. The Coal Fields of New South Wales. Boyd Dawkins (A M S-Began May 6—2 parts to date—30 cts. each).

13303. Testing Explosives at the Produits Colleries, Flenu, Belgium. A. Macquet (C G-Began May 26—Ended June 9—3 parts—30 cts. each).

13315. The Petroleum Industry of Austria-

Hungary. Ill. A. W. Eastlake (I L-Began May 26—Ended June 9—2 parts—30 cts. each).

13410. West Australia Mineral Fields (A M S-Began April 22—4 parts to date—30 cts. each).

13474. Waste in Anthracite Coal Mining (E M J-Began June 10—Ended June 24—2 parts —15 cts. each).

13654. The Wythe Lead and Zinc Mines, Virginia. C. R. Boyd (E M J-Began June 17 —Ended June 24—2 parts—15 cts. each).

13877. The Fuveau Coal Field of France. M. Oppermann (C G-Began June 16—Ended June 23—2 parts—30 cts. each).

RAILROADING.

*13492. The Railway Development of Colombia. Ill. Juan de la C. Posada (E Mag-Aug.) 4000 w.

13508. How to Economize in Tie Renewals. Ill. Benjamin Reece (R A-June 9.) 3000 w.

*13516. Turnonts from Railway Curves. Noah Johnson (Y B S E-1893.) 600 w.

*13518. The Operation of Electric Street Railway Motors. Albert D. McNair (Y B S E-1893.) 3000 w.

*13525. Estimation of Overhaul by Profile of Quantities. O. J. Anderson (Y B S E-1893.) 1500 w.

13527. Pneumatic Car and Truck Jacks. Ill. (R M M-June.) 600 w.

*13532. Irish Light Railway Guarantees. Editorial (Tr-June 2.) 2000 w.

*13542. Two Early Locomotives—the "Cornwall" and the "Hurricane." Ill. (I L-June 2.) 850 w.

*13545. History of the Original Whitby and Pickering Railway, 1833. J. B. Hope (R P L-June 1.) 1650 w.

*13562. Upper Egypt Railway Extension. Ill. (E-June 2.) 1800 w.

*13568. Bessbrook and Newry Electric Tramway. Ill. (E E L-June 2.) 1000 w.

*13570. Automatic Electric Railway Signals. Ill. (E E L-June 2.) 700 w.

13576. Iberian Railway Equipment. Ill. W. Lodia (R R-June 10.) 600 w.

13577. Speculative Railway Construction. Editorial (R R-June 10.) 900 w.

13578. The Law Concerning Assumption of Risks in the Use of Various Styles of Car Couplers. Editorial (R R-June 10) 900 w.

13610. The Broadway Cable Plant, St. Louis. Ill. (S R G-June 10) 1800 w.

13625. Frankfort Terminals and Boats for the Toledo, Ann Arbor and North Michigan Railway Co.'s 63-Mile Transfer. Ill. (E N-June 15.) 3300 w.

13627. Harlem River Drawbridge; New York Central and Hudson River R. R. Ill. (E N-June 15.) 400 w.

13630. A New Form of Break Gear. Ill. (E N-June 15.) 900 w.

13631. Air Brakes in the Lafayette Accident. Editorial (E N-June 15.) 1700 w.

13633. The Relations of Track to Train Service. E. E. Russell Tratman (E N-June 15.) 3300 w.

13635. What the Master Car Builders' Association Has Accomplished. E. W. Grieves (R C J-June.) 1200 w.

13636. California Redwood in Car Construction. Benjamin Welch (R C J-June.) 1800 w.

13637. Hygienic Methods of Passenger Car Construction and Furnishing. G. P. Conn (R C J-June.) 3000 w.

13638. The Relations Between the Master Car Builder and the Master Car Painter. Charles E. Copp (R C J-June) 2400 w.

13639. Ventilation of Railroad Cars. Hygiene (R C J-June.) 600 w.

13640. Cast-Iron Car Wheels. F. A. Stinard (R C J-June) 1800 w.

13641. Paper Car Wheels.—The Philosophy of the Wheel, with a Description of the Processes in Its Manufacture. Ill. Duane Doty (R C J-June.) 1400 w.

13644. Storage Battery Controversy at Hartford (W E-June 17.) 2000 w.

13646. Japanese Railroads (R G-June 16.) 800 w.

13647. Standard Specifications for Rails. Editorial (R G-June 16.) 1300 w.

13648. The Reading Rehabilitation. Editorial (R G-June 16.) 800 w.

13649. How to Examine Firebox Steel. Editorial (R G-June 16.) 1000 w.

13650. Steel for Fireboxes.—A French Study (R G-June 16.) 2000 w.

*13689. Factory-Driving by Electricity on the Northern of France Railway (P Eng-June 9) 1200 w.

13711. Report on Metal for Brake Shoes (R A-June 16.) 2800 w.

13729. Proceedings of the 27th Annual Convention of the Master Car Builders' Association (R R-June 17.) 22000 w.

13730. The Value of Standards. Editorial (R R-June 17.) 1400 w.

13740. Division of Traffic and Maintenance of Rates. S. Y. M'Nair (R G-June 16.) 900 w.

*13749. Car Floors and Cleanliness (S R R-June.) 900 w.

*13750. Overhead Copper Return Circuits. James Riley (S R R-June.) 900 w.

*13751. Tramways of St. Petersburg (S R R-June) 1000 w.

*13752. More About Electrolysis. Ill. (S R R-June.) 700 w.

*13753. The Orange Mountain Cable. Ill. (S R R-June.) 1000 w.

†13756. The "Mud Gorge" Committee Report. Ill. (I E-May 20.) 1600 w.

13777. The Boston Subway Bill. Editorial (E N-June 22.) 2100 w.

13778. Breakages of M. C. B. Couplers (E N-June 22.) 1500 w.

13780. The Louisville and Nashville R. R.

Co.'s New Terminal Yards and Station at Nashville, Tenn. Ill. (E N–June 22.) 500 w.

13786. Street Railway Controversy in San Francisco (W E–June 24.) 1100 w.

13788. The Fusee Danger Signal Compared with the Torpedo. Langdon (R G–June 23.) 1000 w.

13789. The "Useful Effect" of Signals. C. A. Hammond (R G–June 23.) 1400 w.

13790. Valves of the Locomotives Hauling the "Exposition Flyer" (R G–June 23.) 600 w.

13791. The Crane Air Brake Apparatus. Ill. (R G–June 23.) 2000 w.

13792. The Vertical Plane Coupler at the Lakewood Convention. Editorial (R G–June 23.) 2200 w.

13825. Opening Address at the World's Railway Commerce Congress. George R. Blanchard (R A–June 23.) 4000 w.

13826. The World's Fair and the Railways (R A–June 23.) 900 w.

13827. Duties and Knowledge Required of a Superintendent of Bridges and Buildings in the Railway Service. A. Shane (R A–June 23.) 1300 w.

*13844. Traffic Arrangements for the French Universal Exhibition of 1900. Ill. (Eng L–June 16.) 2700 w.

*13847. An Extraordinary Locomotive.—Mr. Heilmann's Patent. Editorial (Eng L–Jnne 16.) 1600 w.

*13862. The Zone System on Hungarian Railways (Tr–June 16.) 1500 w.

*13863. Railway Development in Egypt (Tr –June 16.) 600 w.

13888. Continued Proceedings of the Master Car Builders' Convention (R R–June 24.) 6000 w.

13889. The Outlook for the Master Mechanics' Association.—Address of President J. Hickey at Lakewood (R R–June 24.) 2500 w.

13890. Car Mileage. Editorial (R R–June 24.) 800 w.

13891. The Master Car Builders' Convention. Editorial (R R–June 24.) 1750 w.

13897. The Citizens' Street Railway of Muncie, Ind., with Natural Gas as Fuel. Ill. Leslie W. Collins (E E N Y–June 28.) 2000 w.

†13908. Notes on Cost of Operating Cable Railways. D. Bontecou (T C E–April.) 1800 w.

†13910. Discussion on "Railway Signaling as Applied to Large Installations," by John P. O'Donnell (T C E–April.) 11000 w.

*13924. The Longest Railway in the World (R M–June.) 1200 w.

†13940. The Fastest Train in the World. H. G. Prout (N A R–July) 2600 w.

*13973. Handling the Brake-Valve. Will W. Wood (L E–July.) 900 w.

13981. Railway Construction in Central and South America. William E. Curtis (E N–June 29.) 2500 w.

13983. The Relative Merits of Compound and Simple Locomotives (E N–June 29.) 2000 w.

13984. The Counterbalance System of Operating Electric Cars on Steep Grades. Ill. (E N –June 29.) 1000 w.

13993. Profiles of Five Trans-Continental Railroad Lines. Ill. (R G–June 30.) 800 w.

13994. Railroad Accidents. Their Causes and Prevention. H. S. Haines (R G–June 30.) 6400 w.

13995. A Plan for Shop Tests of Locomotives. Editorial (R G–June 30.) 950 w.

13996. The Limited Pooling of Box Cars. S. H. Church (R G–June 30.) 1400 w.

*13999. The Use of Concrete in Railway Structures. Ill. (E–June 23.) 2500 w.

*14021. The Relation of Railway Signaling to Train Accidents. W. W. Salmon (J A E S–May.) 3100 w.

14028. Plan Proposed by Commissioner Veazey for Protecting Carriers and Shippers (R A–June 30.) 1400 w.

14029. Railways in New South Wales. From Address of Prof. Warren (R A–June 30.) 800 w.

*14031. The Great Railway Systems of the United States.—The Central and Southern Pacific Companies. Ill. F. S. Stratton (Cos–July.) 4000 w.

14038. Power House Design. Ill. E. J. Cook (S R G–July 1.) 1500 w.

*14065. The Proposed Railway from Ceylon to India (Tr–June 23.) 1500 w.

*14066. The Grand Trunk Sensation (Tr–June 23.) 1000 w.

14071. Pullman's World's Fair Trains. Ill. (R R–July 1.) 3000 w.

14072. Arbel Wrought Iron Wheels. Ill. (R R–July 1.) 1500 w.

14091. A New System of Underground Electric Traction.—The Invention of John J. Green. Ill. (E R N Y–July 8.) 800 w.

14102. A Safety Railway Train.—Invention of J. E. Page. Ill. (A S–July 1.) 700 w.

*14109. Compound Locomotives. Editorial (A E R J–July.) 2000 w.

*14113. Jack's Run Vladnct (A E R J–July.) 500 w.

†14116. A Few Notes Concerning Time Tables. John H. Hildreth (S R J–July.) 900 w.

†14117. Novel Cable Incline in India. Ill. (S R J–July.) 900 w.

†14118. San Francisco Electric Lines. Ill. C. B. F. (S R J–July.) 3000 w.

†14119. Oakland, Berkeley and Almeda, Cal. Ill. C. B. F. (S R J–July.) 12000 w.

*14122. The Great Timber Structures of the Canadian Pacific Railway. Ill. (R W–June 2000 w.

*14123. The Bessbrook Electric Tramway. Ill. (R W–June.) 28000 w.

*14124 Depreciation of Tramways. R. S Tresilian (R W–June.) 1200 w.

14131. The Great Northern Railway (M S R–July 1.) 2000 w.

14153. Dining Cars on the Midland R'y, England (E N–July 6.) 1300 w.

14157. Safety Devices Applied to Railway Cars Horace Porter (E N-July 6.) 1200 w.

14170. A Quebec-Labrador Railroad and a New Trans-Atlantic Route. A. W. Palmer (R G-July 7.) 1600 w.

14171. Train Robbing and Train Wrecking. Editorial (R G-July 7.) 1800 w.

14172. Judge Newman on the Long-and-Short Haul Law (R G-July 7.) 1700 w.

☞14173. The Effect of the Silver Crisis on Railroad Securities (R G-July 7.) 800 w.

Serials.

☞11962. The History of the Southeastern Railway. G. A. Sekon (R P L-Began April 1—3 parts to date—30 cts. each).

12001. Rails on the Creep. A. Ewhank (I E-Began March 11—11 parts to date—45 cts. each).

12527. Patenall's Improved Sykes' System of Block Signals. Ill. (A E R J-Began May—3 parts to date—30 cts. each).

13563. A 100-Ton Electrical Locomotive. Ill. C. S. Du Riche Preller (E-Began June 2—Ended June 16—3 parts—30 cts. each).

13758. Plate-laying. Ill. J. E. (I E-Began May 20—2 parts to date—45 cts each).

13855. Couplings. Ill. J. Richards (M W-Began June 16—Ended June 23—2 parts—30 cts. each).

14069. The Effect of Competition upon Railway Construction and Operation. Aldace F. Walker (R R-Began July 1—1 part to date—15 cts).

14125. The Local Transit Problem in London (R W-Began June—1 part to date—30 cts).

SANITARY ENGINEERING.

13506. The Canton, O., Sewerage System. Ill. (E R-June 10.) 2200 w.

†13608. Notes on the Purification of Allegheny River Water by the Anderson Process. Francis C. Phillips (E S W P-April.) 4500 w.

13669. Sanitation. Alexander W. Murray (Met W-June 17.) 2400 w.

†13769. The Public Health.—The Duty of the Nation in Guarding It. T. Mitchell Prudden (C M-June.) 3000 w.

13819. Purification of Water by Freezing. Thomas M. Drown (E R-June 24.) 1700 w.

†13833. Chicago's Sanitary Condition. E. Fletcher Ingals (F-July.) 3800 w.

*13837. The Ground of Safety. R. C. Kedzie (A H-July.) 5500 w.

*13838. Malarious Localities; How They May Be Rendered Salubrious. Charles Smart (A H-July.) 3300 w.

13922. Bathing and Washing Facilities in a Brooklyn Factory. Ill. (Ir Age-June 29.) 1200 w.

*14023. Sewage Disposal. J. Foster Flagg (P-July.) 4000 w.

14133. The Purification of Water (Sc A-July 8.) 950 w.

*14149. Are California Homes as Healthful as They Should Be? Marsdon Manson (I S F-July.) 2500 w.

14162. Sanitation. James H. O'Neill (Met W-July 8.) 1200 w.

†14190. Some Recent Advances in Water Analysis and the Use of the Microscope for the Detection of Sewage Contamination. George W. Rafter (San-July.) 5500 w.

Serials.

10425. A Healthy Home. F. Vacher (S R-Began Feb. 1—10 parts to date—30 cts. each).

11376. Plumbing in the New Netherland Hotel. Ill. (E R-Began March 18—3 parts to date—15 cts. each).

12628. Heating and Ventilation of Residences. Ill. James R. Willett (I A-Began April—3 parts to date—45 cts. each).

13122. The Ventilation and Heating of Schools. Ill. Fred P. Smith (A Ar-Began May 27—2 parts to date—15 cts. each).

13708. Heating in the Wainwright Building, St. Louis, Mo. Ill. (E R-Began June 17—2 parts to date—15 cts. each).

STEAM ENGINEERING.

*13513. Design of a High-Speed Corliss Experimental Engine. J. H. Gill (Y B S E-1893.) 750 w.

*13514. Steam Boiler Explosions. H. E. Smith (Y B S E-1893.) 1000 w.

*13515. Piping for Steam Engines. William A. Pike (Y B S E-1893.) 1000 w.

*13540. Figures for Boiler Duty. W. H. Booth (E L-June 2.) 1800 w.

*13551. Practical Notes on the Steam Jacket. Ill. (E R L-June 2.) 1100 w.

*13574. Steam and Cylinder Condensation (E M-June 2.) 1400 w.

*13575. Relative Value of Steaming Coals. William Kent (E M-June 2.) 1500 w.

*13581. Jacketing and Compression. Editorial (Eng L-June 2.) 1800 w.

*13658. Report of Test of Pumping Engine at North Point Station, Milwaukee, Wisconsin. Ill. R. C. Carpenter (S J E-June.) 6000 w.

*13660. Transmission of Heat from Steam to Air through Iron. Charles Dunn and W G. Mack (S J E-June.) 1000 w.

13671. Circulation of Steam without Pressure above the Atmosphere by the Andrew G. Paul System for Removing Air. A. B. Franklin (Met W-June 17.) 2500 w.

*13677. The Analyses of Engine Tests. Editorial (Eng L-June 9.) 1500 w.

13691. Interception Walls in Rear of Boiler Setting. Paris, Texas (B J C-June 17.) 1300 w.

13743. What Is a Corliss Engine? Editorial (A M-June 22.) 450 w.

13798. A Simple Method of Feeding a Boiler. H. Knowlton (S E-June 10.) 600 w.

*13811. Lining Up an Engine. Robert Grimshaw (S-June) 1900 w.

13828. Selecting an Engine. W. H. Wakeman (M G–June 24) 800 w.

13868. Firing with Natural Draft. Paris, Texas (B J C–June 24.) 1000 w.

*13925. Water-Hammers (R M–June.) 800 w.

*13971. Smoke Preventing.—Jim Skeevers and the Fourth Vice Try Experiments. (Humorous) (L E–July.) 2700 w.

*14005. Triple-Expansion Engine Economy. Editorial (I & I–June 23.) 1000 w.

*14019. A Comparative Test of Types of Smokeless Furnaces. John C. McMynn (J A E S–May.) 1800 w.

*14020. Steam Engine Efficiency—Its Possibilities and Limitations. William H. Bryan (J A E S–May.) 3000 w.

14056. Steam Consumption of an Engine.—How it is Measured from the Indicator Diagram. Ill. (B J C–July 1.) 2600 w.

14070. Boiler Steel. Samson Fox (R R–July 1.) 1500 w.

14107. Boiler Insurance (E R–July 1.) 700 w.

*14111. The Cyclogram of Pressures in Steam Engines. Ill. F. Edwards (A E R J–July.) 700 w.

14121. Engines at the World's Fair. Ill. (P S–July.) 14000 w.

*14129. On the Composition of Smoke. M. P. Laktine (J G L–June 27.) 1400 w.

14146. The Corliss Engine. Ill. Thomas Hawley (C E N–July.) 2800 w.

14186. Massachusetts Law for the Production of Smoke. Editorial (E R–July 8.) 650 w.

14198. Horse Power of a Boiler.—What it Means and How Figured (B J C–July 8.) 1000 w.

14199. Grooving in Steam Boilers. Ill. (B J C–July 8.) 1400 w.

14200. The Automatic Engine.—Its Peculiarities and Special Uses (B J C–July 8.) 750 w.

Serials.

11138. Notes on the Steam Injector. Ill. Strickland L. Kneass (E M–Began March—4 parts to date—30 cts. each).

12377. Steam Shovels and Steam Shovel Work. Ill. E. A. Hermann (E N–Began April 27—7 parts to date—15 cts. each).

13709. The Early Days of Steam Heating. James J. Walworth (E R–Began June 17—Ended June 24—2 parts—15 cts. each).

14040. The Steam Engine (T–Began July 1—1 part to date—15 cts).

TELEPHONY AND TELEGRAPHY.

*13526. The Transmission of Telephone Currents.—Review of book by W. J. Hopkins. Francis G. Baily (N–June 1.) 1000 w.

13585. Reminiscences of Sir J. Anderson. Ill. A. E. Kennelly (E E N Y–June 14.) 700 w.

13733. The Survey for the Pacific Cable (E R N Y–June 24.) 1600 w.

13734. Chinese Telegraph Lines (E R N Y–June 24) 450 w.

13787. New Chicago Office of the Western Union Telegraph Company. Ill. (W E–June 24.) 1500 w.

13968. Destruction of Telephone Cables by Electric Railway Currents. Ill. (W E–July 1.) 1200 w.

*14007. Electric Traction and Telephone Clauses (I & I–June 23.) 900 w.

*14012. Telephone Companies and Electric Traction (E R L–June 23.) 9900 w.

14115. The First Telegraph Money Order (E E N Y–July 5.) 200 w.

MISCELLANEOUS.

*13541. The Sheffield Technical School. Ill. (I L–June 2.) 5000 w.

*13547. Energy as a Fundamental Idea. E. Tremlett Carter (E R L–June 2.) 1000 w.

*13561. The Progress of the Columbian Exposition. J. D. (E–June 2.) 6400 w.

†13584. Protection and the Empire. Walter Frewen Lord (N C–June.) 6000 w.

†13592. Does the Country Demand Free Coinage of Silver? Who Are in Favor, and Who Opposed, and Why? A. C. Fisk (A–June.) 5200 w.

†13593. The Currency Crisis in the United States. Moreton Frewen (F R–June.) 5500 w.

†13594. The City Unification Commission. Charles Harrison (F R–June.) 4000 w.

13621. Interest. C. H. Aaron (M S P–June 10.) 2000 w.

*13675. The Regulation of Explosives. Editorial (Eng L–June 9.) 1800 w.

*13676. The Jury System and the Chicago Exhibition. Editorial (Eng L–June 9.) 800 w.

13775. The Hydraulic Laboratory and Courses of the Massachusetts Institute of Technology. Ill. (E N–June 22.) 2500 w.

13785. Making Silk from Wood (M N–June 15.) 900 w.

*13814. Foreground and Vista at the Fair. Ill. W. Hamilton Gibson (Sc M–July.) 3000 w.

*13824. Our Fire Appliances.—A Comparative Study of Ancient and Modern Implements and Machinery. Ill. (M–June 15.) 3400 w.

†13831. How the Fourth of July Should Be Celebrated. Julia Ward Howe (F–July.) 3500 w.

†13832. The World's Fair Balance-Sheet. Franklin H. Head (F–July.) 4000 w.

*13874. Exhibition of Fire-Extinguishing Appliances (E–June 16.) 1600 w.

*13875. The Columbian Relics at Jackson Park. J. D. (E–June 16.) 5500 w.

*13892. The Commerce of the Arctic Regions. Frederick Schwatka (G G M–May–June.) 1800 w.

*13893. Marvels of Mighty London (G G M–May–June.) 1500 w.

13899. The Paris Fire Alarm System. Ill. (E R N Y–July 1.) 600 w.

13903. A New Engineering Laboratory at the University of Pennsylvania. Ill. Edward T. Child (E W-July 1.) 850 w.

13913. The Needs and Opportunities of a Great Technical College. R. H. Thurston (Sc A S-July 1.) 4000 w.

†13938. Silver Legislation and Its Results. Edward O. Leech (N A R-July.) 4400 w.

†13942. The Family of Columbus. Duke of Veragua (N A R-July.) 2700 w.

†13943. Bimetallic Parity under a Gold Standard. C. Vincent (A-July.) 4300 w.

†13944. The Money Question. C. J. Buell (A-July.) 4300 w.

†13945. Crude Rubber in Many Lands. I. A. Sherman (I R W-June 15.) 1500 w.

†13946. The Coloring of India-Rubber. H. C. van Ryhn (I R W-June 15.) 1600 w.

†13947. The Manufacture and Properties of Celluloid. Walter Hogben (I R W-June 15.) 1000 w.

13979. Good Advice to Engineering Graduates. J. A. L. Waddell (E N-June 29.) 2800 w.

13985. Effect of the Stoppage of Free Coinage in India on the Future of Silver (E M J-July 1.) 1000 w.

13986. Stoppage of Free Silver Coinage in India and Its Immediate Results (E M J-July 1.) 2200 w.

*14003. The World's Columbian Exposition. J. D. (E-June 23.) 6500 w.

*14030. A Turning Point in the Arts. Ill. Charles de Kay (Cos-July.) 4500 w.

*14032. Engineering with a Camera in the Cañons of the Colorado. Ill. Robert B. Stanton (Cos-July.) 4000 w.

*14045. An Englishman's Impressions at the Fair. Rev. F. Herbert Stead (R of R-July.) 4200 w.

14048. Wood Supplanted by Iron. Leicester Allen (M N-July 1.) 1500 w.

14050. A Monster Blast (M N-July 1.) 800 w.

†14093. On Some Dikes Occurring near Lyon Mt., Clinton Co., N. Y. Arthur S. Eakle (A G-July.) 1200 w.

†14094. Englacial Drift. Warren Upham (A G-July.) 2200 w.

†14095. Range of Chontean Fossils. R. R. Rowley (A G-July.) 150 w.

†14096. Erosion of Small Basins in Northwestern Indiana During the Time Preceding the Pleistocene Period. Ill. Charles S. Beachler (A G-July.) 700 w.

†14097. On the Structure and Probable Affinities of Cerionites Dactylioides. Owen S. Calvin (A G-July) 1500 w.

14099. The Money and Silver Question. F. M. F. Cazin (E A-July 8.) 1000 w.

14103. The Young Graduate Engineer. Editorial (E R-July 1.) 900 w.

14132. The Rule of Contrariety in Inventions (Sc A-July 8.) 800 w.

14134. Prehistoric Pottery on Exhibition at the World's Columbian Exposition. Ill. Henry Hales (Sc A S-July 8.) 1600 w.

*14147. Scandinavian Discovery of America (I S F-July.) 2600 w.

14160. The Efficiency of a Low Radiator. C. C. Prince (Met W-July 8.) 1300 w.

14166. Trade Schools and Charity. Charles J. Gillis (A & B-July 8.) 2200 w.

14169. The Waterway from the Lakes to Tide-water and Its Effect upon Transportation Rates. George Y. Wisner (R G-July 7.) 4000 w.

14191. Engineers. W. H. Wakeman (M G-July 8.) 850 w.

Serials.

9401. World's Columbian Exposition (E N-Began Jan. 5—16 parts to date—15 cts. each).

11821. Causes of Fires. C. John Hexamer (J F I-Began April—Ended July—2 parts—45 cts. each).

12382. The Ideal Engineering School (E N-Began April 27—7 parts to date—15 cts. each).

13211. The Seven Ages of Art. E. G. Lind (S A-Began June—2 parts to date—30 cts. each).

13408. Scraps from an Engineer's Note Book (A M S-Began April 20—2 parts to date—30 cts. each).

13620. One Way to See the Exposition. Ill. Fred DeLand (W F E E-Began June—1 part to date—30 cts).

13703. The Dead-Meat Freezing Establishments on the River Plate. James Durie (M W-Began June 9—Ended June 16—2 parts—30 cts. each).

13905. From the Centennial Exposition to the World's Fair. Thomas D. Lockwood (E W-Began July 1—2 parts to date—15 cts. each).

13998. The Future of the Hot-Air Furnace A. W. Glessner (Met W-Began July 1—2 parts to date—15 cts. each).

14194. White Lead. George H. Hurst (O P D R-Began July 10—1 part to date—15 cts).

NEW BOOKS OF THE MONTH.

[For the convenience of readers any American books will be supplied at publishers' prices by The Engineering Magazine Co. Foreign books, 25 per cent. extra.]

Baker, Edward.=Hand-book to Various Publications, Documents and Charts Connected with the Rise and Development of the Railway System Chiefly in Great Britain and Ireland. Birmingham. [120 p., 1s.]

Blyth, Wynter A.=Lectures on Sanitary Law. New York: Macmillan. [12mo, cloth, 298 p., $2.50.]

Catalogue of Blowers, Exhausters, Engines, Forges, and Heating and Ventilating Apparatus. B. F. Sturtevant Co. Boston. [200 p.—Free on application.]

Catalogue of Electric Railway Apparatus. Pittsburg: Westinghouse Electric and Manufacturing Co. [57 p.—Free on application.]

Catalogue of the New Laboratories of Case School of Applied Science. Cleveland, O. [Free on application.]

Delano, W. H.=Twenty Years' Practical Experience of Natural Asphalt and Mineral Bitumen. New York: Spon. [8vo, paper, 73 p., 50c.]

Engineer's and Draughtsman's Data-book for Workshop and Office Use. New York: Spon. [8vo, flex. leather, 122 p., $1.]

Grimshaw, Robert.=Locomotive Catechism. Containing over 1200 questions and answers concerning designing and construction, repairing and running of various kinds of locomotive engines. Intended as examination questions, and to post and remind the engine-runner, fireman, or learner. New York: Norman W. Henley & Co. [12mo, cloth, 360 p., $2.]

Haupt, Herman.=Street Railway Motors. With descriptions and cost of plants and operation of the various systems in use or proposed for motive-power on street railways. Philadelphia: H. Carey Baird & Co. [12mo, cloth, 213 p., $1.75]

Heath, A. H.=A Manual on Lime and Cement; their Treatment and Use in Construction. New York: Spon. [12mo, cloth, 215 p., $2.50.]

Hobhouse, L. T.=The Labor Movement. With preface by R. B. Haldane. On the aims of labor, trade-unionism, co-operation, distribution of wealth, control of industry. Unwin. [8vo, 110 p., 3s. 6d.]

Millls, C. T.=Metal Plate-Work: Its Patterns and Their Geometry. Also, notes on metals and rules in mensuration for the use of tin, iron and zinc plate workers, coppersmiths, boiler-makers, plumbers, and others. New York: Spon. [12mo, cloth, 377 p., $3.50.]

Mines and Mining Men of Colorado: Historical, Descriptive and Pictorial. An account of the principal producing mines of gold and silver, the bonanza kings and successful prospectors, the picturesque camps and thriving cities of the Rocky Mountain Region. Denver: J. G. Canfield. [4to, morocco, 123 p., $2 50; paper, $1.]

Robinson, H.=Comparisons between the Different Systems of Distributing Electricity. New York: Spon. [8vo, 21 p., paper, 80c.]

Searles, J. M.=Life and Times of a Civil Engineer. Also—The True Theory of the Mississippi River. Cincinnati: Robert Clarke & Co. [12mo, paper, 139 p., $1.]

Simon, Andreas.=Chicago, the Garden City. Its magnificent parks, boulevards, and cemeteries, together with other descriptive views and sketches. Chicago: Koelling & Klappenbach. [8vo, paper, 248 p., 75 cts.]

Smith, Albert W.=Constructive Materials of Engineering. Palo Alto, Cal.: Palo Alto Press. [12mo, paper, 86 p, 80 cts.]

Swinburne, J., and Wordingham, C. H.=The Measurement of Electric Currents. Electrical Measuring Instruments, also Meters for Electrical Energy. New York: Van Nostrand. [32mo, 241 p., boards, 50 cts.]

The Electrician "Electrical Trades' Directory and Handbook for 1893." London: The Electrician Printing and Publishing Co. [8vo, 974 p., board, 7s. 6d., postage extra.]

Thompson, Silvanus P., and Smith, Eustace.=Electrical Tables and Memoranda. New York: Spon and Chamberlain. [64mo, roan, 128 p., 50 cts.]

Torrey, Augustus.=Switch Layouts; Showing graphically the leads, offsets, and all dimensions needed for locating frogs of all numbers and curves in all switches in common use, and Curve Easements; Tables of angles, chords and deflections for easing the transition from a tangent to a curve, and from a curve of one radius to a curve of another radius. A work especially valuable to section foremen and assistant engineers. New York: The Railroad Gazette. [12mo, leather, 195 p., $1.]

Wells, E. H.=New York Railroad Corporations. General railroad laws of New York, with decisions and forms; constitutional and statutory provisions affecting steam, street surface, "rapid transit," cable, electric, and other railroads, as found in the New York State constitution, the general corporation law, the stock corporation law, the railroad law, etc., with decisions, cross-references, and forms, also decisions under the "town bounding" acts. New York: Banks & Bros. [8vo, 699 p., sheep $2. paper $1.50.]

Westinghouse Electric Manufacturing Co.—Annual Report of the Board of Directors to the Stockholders. New York: C. G. Burgoyne. [Free on application.]

THE TECHNICAL INDEX.

A CATALOGUE OF LEADING ARTICLES PUBLISHED CURRENTLY IN THE TECHNICAL JOURNALS OF THE UNITED STATES AND GREAT BRITAIN.

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[In the body of the index only the initials of the journals quoted are given, and these can be readily identified by the following list of periodicals. Other abbreviations are: Ill=illustrated. w=words.]

THE AMERICAN PRESS.

A ....Arena. *m.* $5 per year. Boston.
AA......American Architect. *w.* $6. Boston.
An A A..Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
A An.... American Analyst. *f.* $1. New York.
A Ar.... American Artisan. *w.* $2. Chicago.
A B M...Arch. Builder, and Manuf. *m.* $1.50. Kansas City, Mo.
A & B....Architecture and Building. *w.* $6. N. Y.
A C J....Am. Chemical Journal. *b-m.* $4. Baltimore.
A D......American Druggist. *m.* $1.50. N. Y.
A E .....Architectural Era. *m.* $3. New York.
A E R J.Am. Eng. and Railroad Journal. *m.* $3. N.Y,
A G......Am. Geologist. *m.* $3.50. Minneapolis.
A G L J..Am. Gas Light Journal. *w.* $3. New York.
A H......Annals of Hygiene. *m.* $2 per year. Phila.
A J Phar.Am. Journal of Pharmacy. *m.* $3. Phila.
A J R A..Jour. R'y. Appliances. *m.* $2. New York.
A M......American Machinist. *w.* $3. New York.
A M M...Amer. Mechanics. *m.* $1. Minneapolis.
A M & I W.Am. Man. and Iron World. $4. Pittsburg.
Am A....American Agriculturist. *m.* $1.50. N.Y.
Am G....American Gardening. *m.* $1. New York.
Am M...American Miller. *m.* $2. Chicago.
Am S....American Shipbuilder. *w.* $2. New York.
A & N J..Army and Navy Journal. *w.* $6. New York.
A & N R..Army and Navy Register. *w.* $3. Wash'ton.
A R .....Architectural Record. *q.* $1. New York.
A Rev....Architectural Review. *s-q.* $5. Boston.
A S .....Age of Steel. *w.* $3. St. Louis.
At M. ...Atlantic Monthly. *m.* $4. Boston.
B B......Brick Builder. *m.* $2.50. Boston.
B C......Boston Commonwealth. *w.* $2.50. Boston.
B & D...Builder and Dec. *m.* $2. Minneapolis.
B G S... Bul. Am. Geog. Soc. *q.* $5 N. Y.
B I S.. ..Bul. Am. Iron and St. Asso. *w.* $4. Phila.
B J C....Boston Jour. of Commerce. *w.* $3. Boston.
B P......Bulletin of Pharmacy. *m.* $1. Detroit.
B & W...Builder and Woodworker. *m.* $1. N. Y.
C.........Compass. *m.* $1 per year. New York.
C A......Calif. Architect. *m.* $3. San Francisco.
Can A.. Canadian Architect. *m.* $2. Toronto.
C B T... Builder and Trader. *w.* $2. Chicago.
C & B... Carpentry and Building. *m.* $1. New York.
C E .....Colliery Engineer. *m.* $2. Scranton, Pa.
C E N... Canadian Elec. News. *m.* $1. Toronto.
C Eng....Canadian Engineer. *m.* $1. Montreal.
Ch.......Chautauquan. *m.* $2. Meadville, Pa.
C M......Century Magazine. *m.* $4. New York.
Cos.... ..Cosmopolitan. *m.* $1.50 per year. New York.
D E......Domestic Engineering. *m.* $1. Chicago.
D J......Drainage Journal. *m.* $1. Indianapolis.
D Jour..Druggists' Journal. *m.* $1. Chicago.
E A......Electrical Age. *w.* $3 per year. New York.
E E N Y..Electrical Engineer. *w.* $3. New York.
E I.......Electrical Industries. *m.* $3. Chicago.
E M......Engineering Mechanics. *m.* $2. Phila.
E Mag ...Engineering Magazine. *m.* $3. New York.

E M J....Eng. and Mining Journal. *w.* $5. N.Y.
E N.......Engineering News. *w.* $5. New York.
Eng ......Engineer. *s-m.* $2 per year. New York.
E N Y....Electricity. *w.* $2.50. New York.
E P D ...Elec. Prog. and Devel. $2. Boston.
E R.......Engineering Record. *w.* $5. New York.
E R N Y..Electrical Review. *w.* $3. New York
E & R ..Elec. and Railroading. *m.* $1. Boston.
E S W P...Proc. Eng. So. of W.Pa. *m.* $7. Pittsburg.
E W.......Electrical World. *w.* $3. New York.
F . ..Forum. *m.* $5 per year. New York.
F D .....The Foundry. *m.* $1. Detroit.
F M .....Farm Machinery. *m.* $1. St. Louis.
F W .....Fire and Water. *w.* $3 New York.
G & F....Garden and Forest. *w.* $4. New York.
G G M...Goldthwaite's Geograp. Mag. *m.* $2. N.Y.
G R .....Good Roads. *m.* $2 per year. New York.
I A .....Inland Architect. *m.* $5 per year. Chicago.
I Age....Inventive Age. *s-m.* $1. Washington.
Ir Age..Iron Age. *w.* $4.50. New York.
I I G.....Iron Ind. Gazette. *m.* $1.50. Buffalo.
I R W...India Rubber World. *m.* $3 New York.
I S F.....Industry. *m.* $2 per year. San Francisco.
I T R....Iron Trade Review. *w.* $3. Cleveland.
J A . ..Journal of Architecture. *m.* $2. Phila.
J A C S..Jour. Am. Chem. So. *m.* $5. N. Y.
J A E S. Jour. Assoc. Eng. Soc. *m.* $3. Chicago.
J F I.....Jour. Franklin Institute. *m* $5. Phila.
J M S I..Jour. Milit. Service In. *b-m.* $4. NewYork.
J P E.....Jour. Polit. Economy. *q.* $3. Chicago.
J U S A..Jour. U. S. Artillery. *q* $2.50. Ft. Monroe.
L H P ..Light, Heat and Power. *m.* $3. Phila.
L E.......Locomotive Engineering. *m.* $2. N. Y.
L F M....Loco. Firemen's Mag. *m.* $1. Terre Haute, Ind.
L M.......Leather Manufacturer. *m.* $3. N. Y.
L Mag...Lippincott's Magazine. *m.* $3. Phila.
L P .....Louisiana Planter. *w.* $3. New Orleans.
M & B...Manufacturer and Builder. *m.* $1.50. N. Y.
M & El...Mech. and Electrician. *w.* $2. St. Louis.
Met W...Metal Worker. *w.* $2 per year. N. Y.
M G .....Manufacturer's Gazette. *w.* $2.50. Boston.
M I T.....Mining Industry. *w.* $3. Denver.
Min......Minerals. *m.* $1. N. Y.
M N......Mechanical News. *s-m.* $1.50. New York.
M R......Manufacturer's Record. *w.* $4. Baltimore.
M R C...Marine Review. *w.* $2. Cleveland, O.
M Rec....The Marine Record. *w.* $2. Cleveland.
M S P....Min. and Sci. Press. *w.* $3. San Francisco.
M S R....Mining and Sci. Review. *w.* $2. Denver.
N A R...North American Review. *m.* $5. N. Y.
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R'y N....Railway News. *m.* $2. New York.
S... .....Stone. *m.* $2 per year. Indianapolis. Ind.
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San......Sanitarian. *m.* $4 per year. Brooklyn.
Sc........Science. *w.* $3.50 per year. New York.
Sc A ...Scientific American. *w.* $3. New York.
Sc A S...Scientific Am. Supplement *w* $5. N. Y.
Sc M....Scribner's Magazine. *m.* $3. New York.
S E .....Stationary Engineer. *w.* $2. Chicago.
S Era.....Sanitary Era. *m.* $1. N. Y.
Sea .....Seaboard. *w.* $2 per year. New York.
S Ec ....Social Economist. *m.* $2. New York.
S J E....Sibley Jour. of Eng. *m.* $2. Ithaca, N. Y.
S M.....ScientificMachinist. *s-m.* $1.50. Cleveland.O.
So L....Sou. Lumberman. *s-m.* $2. Nashville
S R E N..St. R'y. Elec. News. *m* $2. Minneapolis.
S P......Sanitary Plumber. *s-m.* $1. New York.
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T ... .Tradesman. *s-m.* $2. Chattanooga, Tenn.
T A I E E.Trans. Am. Ins. Electrical Eng. *m.* $5. N. Y.
T C E... Trans. Am. Soc. Civil Eng. *m.* $10. N. Y.
T Q. .....Technology Quarterly. $3. Boston.
W E......Western Electrician *w.* $3. Chicago.
W F E E.World's Fair Elec. Eng. *m.* $3. Chicago.
W G R..Water and Gas Review. *m.* $1. New York.

THE FOREIGN PRESS.

A L ....The Architect. *w.* 26*s.* London.
A M S.. Aust. Mining Standard. *w.* 30*s.* Sydney.
A P R...Aus. Pastoralists' Rev. *m.* 30*s.* Sydney.
B A... .The British Architect. *w* 23*s.* 8*d.* London.
C G.. ..Colliery Guardian. *w.* 27*s.* 6*d.* London.
C R......Contemporary Review. *m.* $4.50. London.
C T J....Chem. Trade Jour. *w.* 12*s.* 6*d.* Manchester.
D.........Discovery *w.* 8*s.* 8*d.* London.
E. ....Engineering. *w.* 36*s.*, London.
E E L....Electrical Engineer. *w.* 17*s.* 4*d.* London.
E G......Engineers' Gazette. *m.* 4*s.*, London.
E L.......Electricity. *w.* 6*s.* 6*d.*, London.
El.. .....Electrician. *w.* 24*s.* London.
Eng L... Engineer. *w.* 36*s.*, London.
E P ......Electrical Plant. *m.* 6*s.*, London.
E R L.....Electrical Review. *w.* 21*s.* 8*d.* London.
F R......Fortnightly Review. *m.* $4.50. London.
G E M...Gas Engrs' Mag. *m.* 6*s.* 6*d.* Birmingham.
G W......Gas World. *w.* 13*s.*, London.
I & I.....Industries and Iron. *w.* £1. London.
I & S.....Iron and Steel Trades' Jour. *w.* 25*s.* London.
C B ....Carpenter and Builder. *w*8*s.* 8*d.* London.
I C T ... Iron and Coal Review. *w.* 30*s.* 4d., London.
I E ......Indian Engineering. *w* 18 Rs. Calcutta
I Eng... Indian Engineer. *w.* 20 Rs. Calcutta.
Inv ..Invention. *w.* 28*s.*, London.
J G L....Journal of Gas Lighting. *w.* London.
J S A....Journal of the So. of Arts. *w.* London.
K.........Knowledge. *m.* 6*s.*, London.
M.........Machinery. *m.* 9*s.*, London.
M E......Marine Engineer. *m.* 7*s.* 6*d.* London.
M E & E J Man. Eng. and Export Jour. *m.* London.
Min W..The Mining World. *w.* 21*s.* London.
M W.....Mechanical World. *w.* 8*s.* 8*d.* London.
N....... Nature. *w.* $7., London.
N C......Nineteenth Century. *m.* $4.50 London.
P Eng...Practical Engineer. *w.* 10*s.* London.
Pl D .....Plumber and Decor. *m.* 6*s.* 6*d.* London.
R N......Railway News. London.
R P L....The Railway Press. *m.* 7*s.* London.
R R L...The Railway Review. *w.* London.
R W.....Railway World. *m.* $3, London
S L.....Steamship. *m* Leith, Scotland.
S R......Sanitary Record. *m.* 10*s.* London.
Tr.......Transport. *w.* £1. 5*s.* London.
W R.....Westminster Review. *m.* $4.50. London.

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*14905. Choice of Wall Papers (I C B-July 28.) 900 w.

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7121. Office-Helps for Architects. Ill. George Hill (A A-Began Oct. 8—15 parts to date—15 cts. each).

7421. French Cathedrals. Barr Ferree (A R-Began Oct.-Dec.—3 parts to date—30 cts. each).

10682. The Chateaux of France. Ill. Louis H. Gibson (S-Began Feb.—6 parts to date—30 cts. each).

12425. The Weathering of Building Stone. George P. Merrill (S-Began April—4 parts to date—30 cts. each).

12568. Building Construction and Superintendence. F. E. Kidder (A & B-Began May 6—7 parts to date—15 cts. each).

12966. An Architectural Knock-About. F. L. V. Hoppin (A A-Began May 20—Ended July 15—8 parts—15 cts. each).

13358. Modern Asylums for the Insane. Ill. George H. Bibby and Ernest A. Woodrow (A A-Began June 3—3 parts to date—15 cts. each).

13407. Terra-Cotta and Faience as Materials for Architectural and Decorative Application

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14018. Geometry in Design. H. A. Sannders (A L–Began June 23—Ended June 30—2 parts—30 cts. each).

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*14699. The Cleveland Bridge and Engineering Co.'s Works, Darlington. Ill. (Eng L–July 21.) 1500 w.

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14325. Keys. W. H. Booth (A M–July 13.) 1300 w.

14480. An Interview with Jacquard Nearly a Century Ago (Sc A–July 22) 900 w.

14488. A Remarkable Job of Boring. Ill. (A M–July 20.) 1700 w.

14489. Combination Drop Dies. B. F. Spalding (A M–July 20.) 2500 w.

*14549. The Rating of Machinery in Foreign Countries. Editorial (E–July 14.) 1700 w.

*14557. Machinery in South Africa. The Demand and Opportunities in the Transvaal (M–July 15.) 2200 w.

14635. Locomotives and Other Early Machines. W. H. Booth (A M–July 27.) 1000 w.

14636. Planing Machine for Forming Cycloidal Surfaces. Ill. Invention of John F. Wilkin (A M–July 27.) 1600 w.

14640. The Great Exhibit of the Self-Winding Clock Company at the World's Columbian Exposition. Ill. (Sc A–July 29.) 1800 w.

14723. The Torsion Viscosimeter. Ill. O. S. Doolittle (A G L J–July 31.) 1300 w.

14725. Precision Planimeters. Ill. (C–Aug.) 1100 w.

14831. Compressed Air and the Way It Is Wasted. Frank Richards (A M–Aug. 3.) 1700 w.

14916. Moulding Big Wheels.—A Machine that Accurately Casts All the Segments at One Time (B J C–Aug. 5.) 400 w.

14979. A Leaf from John Johnson's History. C. L. Redfield (A M–Aug. 10.) 2000 w.

14980. Coal Conveyor at Weehawken, N. J. Ill. (Sc A–Aug. 12.) 500 w.

Serials.

11246. Mechanical Engineering Materials. Ill. Edward C. R. Marks (P Eng–Began March 3—9 parts to date—30 cts. each).

12142. On Machine Designing (M W–Began April 7—8 parts to date—30 cts. each).

14394. The Lancashire Watch Company. Ill. (E–Began July 7—Ended July 21—3 parts—30 cts. each).

14879. The Battle of the Typewriters (Inv–Began July 29—1 part to date—30 cts).

14945. Progressive Pattern Making. Joseph Leon Gobeille (S M–Began Aug. 1—1 part to date—15 cts).

METALLURGY.

*14214. Alloys of Aluminium (C T J–July 1.) 800 w.

14217. Pyritic Smelting (M I T–July 6.) 1300 w.

14229. Causes of Faults in Steel (E N Y–July 8.) 600 w.

14240. Annealing Steel — Importance — Methods. B. F. Spalding (A S–July 8.) 2200 w.

*14254. The Present Depression in the Iron Trade as Affected by Currency Questions. W. H. Houldsworth (I C T–June 30.) 3000 w.

*14266. Concentrating Ironstone Ore. Walter J. May (C G–June 30.) 1200 w.

14275. Silver Statue of Columbus at the World's Fair. Ill. (M & B–June.) 1000 w.

14278. Progress in Metallurgical Industries (M S R–July 6.) 1300 w.

14321. Nau's Method of Making Metal Plates. John B Nau (Sc A S–July 15.) 2500 w.

14335 Chemistry as Applied to the Iron Foundry Industry, with Discussion. W. C. Henderson (Ir Age–July 13.) 3300 w.

14343. How to Make Durable Roofing Plates. James B. Scott (I T R–July 13.) 1500 w.

14357. Steel Plate Chimneys. Ill. Fred W. Gordon (M R–July 14.) 2000 w.

14379. Why is Steel not made South? (T–July 15.) 1400 w.

14411. The Reduction of Phosphorus in Pig Iron. N. Kjellberg (E M J–July 15.) 1300 w.

*14421. The Invention of Crucible Steel (Inv–July 8.) 1500 w.

*14446. On the Chicago World's Fair of 1893, and Its Lessons to the Iron Trade of Great Britain. J. S. Jeans (I & S–July 8.) 6000 w.

*14453. Aluminium Brass and Bronze (M W–July 7.) 1300 w.

14510. How to Make Sheet Metal Boats. Ill. (Met W–July 22.) 2000 w.

14529. Construction of Wrought Iron Chimneys (A A–July 22.) 1500 w.

14533. The Sulphuric Acid Process for Refining Lixiviation Sulphides. H. C. Bellinger (E M J–July 22.) 1500 w.

14534. The Estimation of Gold and Silver in Antimony and Bismuth. Ernest A. Smith (E M J–July 22.) 300 w.

*14564. Peat Charcoal and Bog Ore. Walter J. May (C G–July 14.) 1100 w.

14571. Manganese in Steel (A S–July 22.) 1500 w.

†14621. The Doom of Silver. Edward O. Leech (F–Aug.) 3700 w.

14658. The Chemist as a Factor in Foundry Practice, with Discussion. H. O. Chute (Ir Age–July 27.) 3000 w.

*14674. The Electrolytic Extraction of Gold. Ill. (El–July 21.) 450 w.

14687. Plumbago Foundry Facings (Met W–July 29.) 850 w.

14692. The Alkaline Sulfide Process of Producing Nickel. Stephen H. Emmens (E M J–July 29.) 950 w.

14695. Iron Alloys, with Special Reference to Manganese Steel. R. A. Hodfield (E M J–July 29.) 14500 w.

*14700. United States Competition in the Steel and Engineering Trades. Ewing Matheson (Eng L–July 21.) 5200 w.

*14709. The Manufacture of Charcoal Iron from the Bog and Lake Ores of Three Rivers District, Province of Quebec, Canada. P. H. Griffin (C G–July 21.) 3000 w.

14738. A Simple Mechanical Coke Drawer. Edmund C. Pechin (A M & I W–July 28.) 700 w.

14740. Concentrating Calcined Ironstone. Walter J. May (Inv–July 22.) 1000 w.

14750. Some of the Mutations which Copper, Silver, Steel, Pewter, etc., Have Undergone (B J C–July 29.) 950 w.

14809. Review of American Blast Furnace Practice. E. C. Potter (Ir Age–Aug. 3.) 3800 w.

14810. Changes in the Constitution of the Amalgamated Association (Ir Age–Aug. 3.) 1500 w.

14833. Preventing Gold Robberies from Mills (M S P–July 29.) 1500 w.

14837. A Proposed Method of Testing Structural Steel, with Editorial. Ill. Alfred E. Hunt (E N–Aug. 3.) 7500 w.

*14847. On the Use of Sodium Carbonate for "Blueing" the Copper Solution in the "Cyanide" Assay. G. F. Beardsley (A M S–June 17.) 900 w.

14861. Blowing Engines. Ill. Julian Kennedy (I T R–Aug. 3.) 1500 w.

14913. Scaffolding in Blast Furnaces (A M & I W–Aug. 4.) 600 w.

*14935. The New Siemens Furnace. From paper by M. E. Damour (I & S–July 29.) 4000 w.

14975. The Old "Britton" Mill (Ir Age–Aug. 10.) 350 w.

14976. Welded Seams in Plates. Ill. Warren E. Hill (Ir Age–Aug. 10.) 4000 w.

14977. Segregation and Its Consequences in Ingots of Steel and Iron. Alexander Pourcel (Ir Age–Aug. 10.) 2500 w.

14981. Alloys of Aluminum (Sc A–Aug. 12.) 900 w.

Serials.

10464. The Silver Plating Industry (I & I–Began Feb. 3—4 parts to date—30 cts. each).

12714. The Practical Zinc Worker. Ill. J. Eden Crane (Pl D–Began May 1—3 parts to date—30 cts. each).

12897. Iron and Steel at the World's Columbian Exposition. E. C. Potter (Ir Age–Began May 18—4 parts to date—15 cts. each).

13880. Aluminium—Its Production, Properties, and Uses (Inv–Began July 1—7 parts to date—30 cts. each).

14141. Late Improvements in Copper Smelting. Dr. Peters, Jr. (A M S–Began May 20—2 parts to date—30 cts. each).

14180. The Effect of Impurities in Iron and Steel When Manufacturing Tin Plates. John Bromilow (A M & I W–Began July 7—Ended July 21—3 parts—15 cts. each).

14188. The Specific Heats of the Metals. Joseph W. Richards (J F I–Began July—2 parts to date—45 cts. each).

14393. Rapid Methods for the Analysis of Iron and Steel. J. J. Morgan (I & I–Began July 7—1 part to date—30 cts).

14915. Washed Coal for Coking. Walter J. May (A M & I W–Began Aug. 4—1 part to date—15 cts).

14974. Rod-Rolling Mills and Their Development in America. Ill. Fred. H. Daniels (Ir Age–Began Aug. 10—1 part to date—15 cts).

MILITARY ENGINEERING.

*14223. The Loss of H. M. S. "Victoria." Ill. (Eng L–June 30.) 1500 w.

*14224. The Loss of the "Victoria." Editorial (Eng L–June 30.) 1400 w.

14228. Straightening Rifle Barrels (E N Y–July 8.) 700 w.

*14232. A Scientific and Artistic Miniature Rifle Range (Inv–July 1.) 1100 w.

*14242. The Loss of the "Victoria." Ill. Editorial (E–June 30.) 3800 w.

*14244. Engine-Room Complements. Editorial (E–June 30.) 1350 w.

14320. The New Battleship "Massachusetts." Ill. (Sc A S–July 15.) 1700 w.

14336. Naval Ships and Guns Abroad (Ir Age–July 13.) 1000 w.

†14338. Vertical Fire. Ill. Henry L. Abbot (J U S A–July.) 3500 w.

†14340. A New Powder.—The Present Phase of Smokeless Compounds. Willoughby Walke (J U S A–July.) 2000 w.

†14341. On the Determination of the Combustion Temperature of Explosives. Nikolaus Ritter von Wuich (J U S A–July.) 3000 w.

14362. Magazine Arm vs. Single Loader. X. (A & N J–July 15.) 1600 w.

14363. Armor Tests at Indian Head (A & N J–July 15.) 850 w.

*14438. The Sinking of the "Victoria," with Editorial (Eng L–July 7.) 2000 w.

*14472. Trial Trip of the Cruiser "New York." Albert Franklin Matthews (Ch–Aug.) 2400 w.

14508. Wonderful Tests of American Armor Plates and Projectiles (B I S–July 19.) 1000 w.

14639. Naval Torpedoes (Sc A–July 29.) 1000 w.

*14697. Naval Rams. Editorial (Eng L–July 21.) 1000 w.

†14759. The Lesson of the "Victoria" Disaster. William McAdoo (N A R–Aug.) 2000 w.

*14824. Admiral Tryon and the "Victoria" Disaster. Ill. (R of R–Aug.) 7000 w.

14982. The Loss of H. M. S. "Victoria." Ill. (Sc A S–Aug. 12.) 1750 w.

Serials.

14246. The Model Battleship "Illinois" (E–Began June 30—Ended July 7—2 parts—30 cts. each).

14339. A Contribution to the Interior Ballistics of Smokeless Powders. Lucien G. Berry (J U S A–Began July—1 part to date—45 cts).

14342. Artillery Difficulties in the Next War. John W. Buckman (J U S A–Began July—1 part to date—45 cts).

MINING.

*14210. Facts as to the Silver Industry. Albert Willams, Jr. (E Mag–Sept.) 4500 w.

*14233. Dirty and Clean Fuels with Their Practical Values. Walter J. May (Inv–July 1.) 900 w.

*14239. Coal Consumption in the British Navy (E G–July.) 1600 w.

*14241. Burmah and Its Oil Fields. Ill. (E–June 30.) 4000 w.

*14265. Safe Blasting with Higher Grisontite. Prof. Macquet (C G–June 30.) 4400 w.

*14267. The Arrangement of Labor, Daily Routine and System of Wage Bills General at Collieries in Durham and Northumberland. H. F. Bulman (C G–June 30.) 3800 w.

14277. The Utilization of Anthracite Waste. W. H. Blanvelt (M S R–July 6.) 1400 w.

*14280. The Burra Burra Rush.—Field Declared to be a Failure (A M S–May 27.) 1700 w.

*14281. Co-operation in Coal Mining. Editorial (A M S–June 3.) 950 w.

*14328. The Mount Lyell Deposit.—Interview with Dr. Peters (A M S–June 10) 1000 w.

14331. Queer Ideas About Miners (M S P–July 8.) 500 w.

14332. Ancient River Beds of the Forest Hill Divide (M S P–July 8.) 1400 w.

14333. Aurifernus Conglomerates of the Witwatersrand. A Peculiar Occurrence of Gold in the Famous South African Camp. (M S P–July 8.) 3000 w.

14361. Some Early Petroleum History. A. C. Ferris (O P D R–July 17.) 1500 w.

*14408. Some Recent Investigations of the Geology of the Punjab Salt Range. G. W. Bulman (K–July 1.) 2000 w.

14410. Activity in the New River Coal Field, West Virginia. Edmund C. Pechin (A M & I W–July 14.) 1200 w.

*14426. Experiments with Coal Dust. Henry Hall (C G–July 7.) 2200 w.

*14427. Notes on the Scottish Shale Works. James Constable (C G–July 7.) 1800 w.

*14439. The Utilization of Small Coal. Editorial (Eng L–July 7.) 1500 w.

†14507. The True History of the Knh-i-nur. Ill. V. Ball (I E–June 17.) 3500 w.

14536. The Turkey Heaven Gold District, Alabama. Ill. W. M. Brewer (E M J–July 22.) 700 w.

14537. Some Features of British Mining. S. H. North (E M J–July 22.) 850 w.

*14565. On Earth Pulsations and Mine Gas. John Milne (C G–July 14.) 3000 w.

*14566. Miner's Wages. Editorial (C G–July 14) 1700 w.

14589. The Eye Opener. Edmund C. Pechin (A M & I W–July 21.) 2000 w.

14629. The Colorado Silver Convention's Address to the People of the United States (M I T–July 20.) 2500 w.

14690. The Evolution of the Anthracite Coal Breaker (E M J–July 29.) 600 w.

14694. The Gold Fields in South Africa. Ill. (E M J–July 29.) 2000 w.

*14708. Winches and Haulage Engines for Mines. M. C. Levet (C G–July 21.) 3000 w.

*14710. Mining Exhibition at Gelsenkirchen (C G–July 21.) 850 w.

14739. Tests of Mine Safety Lamps (A M & I W–July 28.) 700 w.

*14747. Experiments on the Combustion of Anthracite Fuel (I C T–July 21.) 900 w.

*14748. The Coal Trade Crisis. Editorial (I C T–July 21.) 1200 w.

*14755. Gold Mining in the Colar Field of Mysore, India (Min W–July 22.) 1800 w.

14769. Lessons of a Coal Crisis. Editorial (A S–July 29.) 700 w.

14780. Coal as a Source of Power. Horace B. Gale (P S–Aug.) 4200 w.

*14811. About Those Who Affect Locomotive Coal Consumption. Editorial (N C B–Aug.) 2500 w.

14814. Alabama Gold Fields (T–Aug. 1.) 1000 w.

14850. The Sado Mines in Japan. Ill. Wadr Tsnnashiro (E M J–Aug. 5.) 800 w.

*14869. Mining Accidents and Employers Liability. Editorial (Eng L–July 28.) 1700 w.

*14906. Yankee Girl Silver Mines, Limited. (Min W–July 29.) 3000 w.

*14910. Twelve-Mile Outfall Drift to the Sea for the Bouches-du-Rhone Colliery, France. M. Domage (C G–July 28.) 3500 w.

*14911. The Wages Question in the Coal Trade (C G–July 28.) 2000 w.

*14922. Methods of Tin-Mining in the Malay Peninsula (P Eng–July 28.) 850 w.

†14928. The Unconformity of the Coal Measures and the St. Louis Limestone in Iowa. Charles Rollin Keyes (A G–Aug.) 1200 w.

*14936. A Japanese Coal Mine (I & S–July 29.) 4100 w.

Serials.

13410. West Australia Mineral Fields (A M S–Began April 22—7 parts to date—30 cts. each).

14282. A Ride to Mount Lyell. George D. Mendell (A M S–Began June 3—2 parts to date—30 cts. each).

14334. Pocket Mines. Alex. Quartz (M S P–Began July 8—4 parts to date—15 cts. each).

14428. Mining Labor (C G–Began July 7—2 parts to date—30 cts. each).

14693. The South Wilkes-Barre Coal Breaker. Ill. (E M J–Began July 29—2 parts to date—15 cts. each).

14923. Coal-Cutting by Machinery. J. William Chubb (P Eng–Began July 28—1 part to date—30 cts).

14946. Gold Mining (M W–Began July 28—1 part to date—30 cts).

RAILROADING.

*14212. Distance Not a Factor in the Cost of Railway Traffic. James L. Cowles (E Mag–Sept.) 3000 w.

*14222. A Visit to a Fog-Signalling Apparatus (R R L–June 30.) 1000 w.

*14245. The Projected Railway in British East Africa (E–June 30.) 2700 w.

14248. Passenger Tickets—Defects of Existing Systems—Special Contracts and Conditions, etc. George H. Heafford (R A–July 7.) 2500 w.

14249. Tender Frames (R A–July 7.) 800 w.

*14253. The Iron and Steel Industries and Colonial Railway Development. W. S. Cairie (I C T–June 30.) 3500 w.

14287. The Missouri Railroad Company of St. Louis (S R G–July 8.) 1800 w.

14288. California Street Cable Railway, San Francisco. Ill. (S R G–July 8.) 1300 w.

14290. The Economy of Street Railways. James B. Cahoon (E W–July 15.) 1600 w.

14297. Concentric Cable Phenomena in Alternate Current Working. Ill. L. Neustadt (E E N Y–July 12.) 1000 w.

14345. Yard Limits. Langdon (R G–July 14.) 800 w.

14346. The Prevention and Control of Strikes on Railroads (R G–July 14.) 1300 w.

14347. Electric Welding of Rail Joints. Ill. (R G–July 14.) 1000 w.

14348. Air-Brake Tests—Report of the M. C. B. Committee. Ill. (R G–July 14.) 3000 w.

14349. Stability of a Trestle Bridge—Effects of a Flood. Ill. Emile Low (R G–July 14.) 350 w.

14351. Railroad Building in the First Half of 1893, with Editorial (R G–July 14.) 3000 w.

14352. Screens and Strainers for Air-Brake Pipes. Editorial (R G–July 14.) 1350 w.

14353. Electric Motors for Steam Roads.—A Step in Progress (R G–July 14.) 3200 w.

14412. The Subway at Sacramento Avenue under the Chicago and Northwestern Railway Tracks, with Editorial. Ill. (R A–July 14.) 1100 w.

14413. International and Interstate Railway Arrangements. G. R. Blanchard (R A–July 14.) 6000 w.

14430. Transfer Car in Indianapolis to be Abandoned (S R G–July 15.) 1200 w.

*14444. Railway Rates and State Control (Tr–July 7.) 1500 w.

14451. Necessity for a Prescribed Minima of Transportation Charges. Editorial (R R–July 15.) 1000 w.

14452. The Economic Value of Large Capacity Freight Cars (R R–July 15.) 1200 w.

14465. The Electric Railway Work of Dr. Colton in 1847.—The First Use of Track as Circuit. T. C. Martin (E E N Y–July 19.) 4000 w.

14470. Water Pressure System in Pullman Cars. Ill. Duane Doty (R C J–July.) 800 w.

14477. Protective Devices on Street Railroads (Sc A–July 22.) 900 w.

14481. Kollman's Locomotive Railway Apparatus. Ill. (Sc A S–July 22.) 1400 w.

14502. Air-Brake Exhibits at the World's Columbian Exposition. Ill. (E N–July 20.) 5000 w.

14515. An Air-Brake Pressure Regulator. Ill. (R G–July 21.)

14516. New York-Chicago Passenger Matters. Editorial (R G–July 21.) 1200 w.

14517. Is the Pneumatic Train Signal Unnecessary? (R G–July 21.) 900 w.

14518. The New Scotch Dining-Car Expresses. W. M. Acworth (R G–July 21.) 1800 w.

14520. Organization of the Accounting Department (R G–July 21.) 1800 w.

*14541. The Return for Electric Railways. Ill. (E R L–July 14.) 1600 w.

*14551. An English View of American Railways. Clement E. Stretton (E–July 14.) 1700 w.

*14552. Ship Railways. Ill. Walter Robert Kinipple (E–July 14.) 7200 w.

*14561. Electric Tramway Traction. Editorial (Eng L–July 14.) 1400 w.

*14562. One Hundred Miles an Hour. Editorial (Eng L–July 14.) 900 w.

*14563. Railway Communication between India and Ceylon. Editorial (Eng L–July 14.) 1100 w.

*14568. High Speed Electric Railway from Brussels to Antwerp (A J R A–July.) 700 w.

*14569. The English System of Railway Signals. Edward Sauvage (A J R A–July.) 1400 w.

14578. Progress in the Adoption of Railway Safety Appliances. Abstract of Paper by Arthur W. Loper (R A–July 21.) 900 w.

14579. Locomotive Supply Station.—Philadelphia and Reading Railroad, Market Street, Philadelphia. Ill. (R A–July 21.) 900 w.

*14582. The City and South London Railway Carriages. F. R. L. Ill. (E E L–July 14.) 900 w.

*14585. Sixty Years of Railway Progress (P Eng–July 14.) 1750 w.

*14593. Electric Tramway Constructed by Messrs. O. L. Kummer & Co. of Niedersedlitz-Dresden. Ill. (E L–July 14.) 1000 w.

14617. Stay-Bolts (R R–July 22.) 1350 w.

†14633. The Khojak Rope Inclines. Walter James Weightman (I Eng–June 17.) 2200 w.

†14634. Railroading as a Profession. Editorial (I Eng–June 17.) 2500 w.

14642. Horatio Allen's Ride (Sc A S–July 29.) 1800 w.

14659. The Wolhaupter Brake Pressure Regulator. Ill. (E N–July 27.) 1000 w.

14663. European Railway Practice: Reports of the International Railway Congress (E N–July 27.) 2400 w.

14665. The Cattle-Guard Problem (E N–July 27.) 700 w.

14679. Accounting on the Western Maryland. J. M. Hood (R G–July 28.) 2000 w.

14680. The New Sixth Street Bridge, Pittsburg, Pa. Ill. (R G–July 28.) 2100 w.

14681. Roberts' Perforated Deflecting Plate. Ill. (R G–July 28.) 1000 w.

14683. The Union Pacific Discrimination Case. Editorial (R G–July 28.) 1500 w.

*14706. An Eloquent Plea for Railway Men's Betterment (R R L–July 21.) 1600 w.

*14746. Railway Extensions in India and Burmah (I C T–July 21.) 2300 w.

14763. The Intercontinental Railway. Ill. W. D. Kelley (Cos–Aug.) 8600 w.

*14771. Steel Under-Frames for Cars and Tenders. Editorial (L E–Aug.) 1000 w.

*14772. Boiler and Cylinder Proportions (L E–Aug.) 1800 w.

*14774. Invention of the Link Motion. James Hedley (L E–Aug.) 1000 w.

*14775. Lining Guides. Ill. G. K. Wentworth (L E–Aug.) 800 w.

*14776. Some Figures on the Magnitude of the Engineering Work on the Gothard Railroad. Ill. Henry Gretener (L E–Aug.) 1200 w.

*14777. A Practical Man's View of Compound Locomotives. G. R. Joughins (L E–Aug. 1400 w.

14779. Railway Transportation vs. Railway Speculation. Editorial (R R–July 29.) 1000 w.

*14790. The Use of Cast Steel in the Manufacture of Different Parts of Locomotives. Ill. (A E R J–Aug.) 1800 w.

*14791. Standard Freight Engines of the Belgium State Railways. G. Braet (A E R J–Aug.) 1200 w.

*14793. Uses of Metallic Ties. A. Flamache (A E R J–Aug.) 3000 w.

14794. Tests of a Storage Battery for Street Car Use. John W. Langley and Charles F. Mabery (S R G–July 29.) 2000 w.

14798. The Care of Motors for Electric Street Railways. James B. Cahoon (E W–Aug. 5.) 2200 w.

†14801. Opening of the Pasadena and Mt. Wilson Railway. Ill. (S R J–Aug.) 750 w.

†14802. The Electric Street Railway in Marseilles, France. Ill. John McGhee (S R J–Aug.) 3500 w.

†14803. A Large Direct Connected Railway Unit. Ill. E. J. Cook (S R J–Aug.) 600 w.

†14804. Los Angeles. Ill. C. B. F. (S R J–Aug.) 4400 w.

†14805. Transmission of Power in Operating Cable Railways. (Abstract.) Robert Gillham (S R J–Aug.) 5500 w.

†14806. Performance of Street Railway Power Plants. (Abstract.) William A. Pike and T. W. Hugo (S R J–Aug.) 3000 w.

†14807. Growth and Possibilities of the Suburban Electric Railway. A. H. Chadbourne (S R J–Aug.) 1200 w.

*14812. Best Form of Staybolts and Method of Inspection (N C B–Aug.) 4000 w.

14855. The Responsibility of the Civil Engineer on Railroads (R G–Aug. 4.) 2000 w.

14859. Increased Tractive Power on Existing Elevated Railroad Structures. Editorial (R G–Aug. 4.) 900 w.

*14867. Port and Railway Concessions at San Clemente (Eng L–July 28.) 900 w.

14871. Concerning Car Wheels (R A–Aug. 4.) 1400 w.

*14890. Third Class Dining Cars. Editorial (E–July 28.) 1000 w.

*14896. Proposed Electric Underground Railway for Brussels. F. B. L. (E E L–July 28.) 1000 w.

14902. Rating of Engines. Editorial (R M M–Aug.) 1500 w.

14920. The Niagara Falls Park and River Railway. Ill. (C E N–Aug.) 3000 w.

14938. A Car Clearing House Needed. Editorial (R R–Aug. 5.) 1000 w.

14939. Light vs. Heavy Locomotives (R R–Aug. 5.) 1300 w.

14961. The Electric Portage between Lakes Ontario and Erie. Ill. T. C. Martin (E E N Y–Aug. 9.) 3800 w.

14978. The Limitation of Engine Speed. Charles T. Porter (Ir Age–Aug. 10.) 1500 w.

Serials.

7456. The Locomotive Boiler. Ill. Gustav Richard (A J R A–Began Oct.—7 parts to date—30 cts. each).

11962. The History of the Southeastern Railway. G. A. Sekon (R P–Began April 1—4 parts to date—30 cts. each).

12001. Rails on the Creep. A. Ewbank (I E–Began March 11—15 parts to date—45 cts. each).

12527. Patenall's Improved Sykes' System of Block Signals. Ill. (A E R J–Began May—Ended Aug.—4 parts—30 cts. each).

14069. The Effect of Competition Upon Railway Construction and Operation. Aldace F. Walker (R R–Began July 1—2 parts to date—15 cts. each).

14125. The Local Transit Problem in London (R W–Began June—2 parts to date—30 cts. each).

14226. Railway Rates and State Control (Tr–Began June 30—5 parts to date—30 cts. each).

14456. The Locomotive Works and Engines of the L. B. and S. C. Railway. G. A. Sekon R P–Began July 1—1 part to date—30 cts).

14519. The Second Decade of the Massachusetts Railroad Commission. William A. Crafts (R G–Began July 21—2 parts to date—15 cts. each).

14651. Shop Notes from Cincinnati. George D. Shepardson (S R G–Began July 22—1 part to date—15 cts).

14682. Staybolt Inspection and Specifications. Ill. (R G–Began July 28—Ended Aug. 4—2 parts—15 cts. each).

14778. Principles of Railway Legislation. Martin A. Knapp (R R–Began July 29—2 parts to date—15 cts. each).

SANITARY ENGINEERING.

*14415. Sanitation and Sanitary Education of Plumbers. Mr. Moxham (Pl D–July 1.) 1700 w.

*14417. Epidemics and Sanitation. W. N. B. (Pl D–July 1.) 1000 w.

*14437. An American Sewage Pumping Plant (Eng L–July 7) 1700 w.

14454. Ventilation and Walls (A Ar–July 15.) 1000 w.

14462. Sanitation. T. C. Boyd (D E–July 15.) 1200 w.

14463. Misguided Sanitarians.—The Smead System Looked at Differently (D E–July 15.) 700 w.

14467. The Woolf Electrolytic Disinfectant. Ill. (E E N Y–July 19.) 1400 w.

14509. Experiments with Water Traps. Ill. (Met W–July 22.) 1200 w.

*14514. The Ozonine Process of Sewage Purification (J G L–July 11.) 700 w.

*14576. How Disinfection is Carried Out in Germany (S R–July 8.) 1000 w.

*14591. New Plumbing By-Law of the City of Montreal (Can A–July.) 2000 w.

*14613. "Izal," A New Non-Poisonous Disinfectant (Inv–July 15.) 2200 w.

†14624. Municipal Sanitation in Washington and Baltimore. John S. Billings (F–Aug.) 4500 w.

14662. Pumping Machinery Tests at the Bridgeport Sewage Pumping Station, Chicago, Ill. (E N–July 27.) 1200 w.

14765. How to Make a City Cholera Proof. Poultney Bigelow (Cos–Aug.) 3900 w.

14823. Southampton Sewage Precipitation Works and Refuse Destructor. William B. G. Bennett (Sc A S–Aug. 5.) 3000 w.

14841. Plumbing for a City House. Ill. (C & B–Aug.) 2200 w.

*14888. Refuse Destructors (I & I–July 28.) 900 w.

*14889. Factory Nuisances. Editorial (E–July 28.) 3000 w.

Serials.

5358. Sewage Purification in America. Ill. (E N–Began July 14, 1892—29 parts to date—15 cts. each).

10425. A Healthy Home. Ill. Francis Vacher (S R–Began Feb. 1—12 parts to date—30 cts. each).

11376. Plumbing in the New Netherlands' Hotel. Ill. (E R–Began March 18—4 parts to date—15 cts. each).

12628. Heating and Ventilation of Residences. Ill. James R. Willett (I A–Began April—Ended July—4 parts—45 cts. each).

13290. Sewage Disposal. J. Foster Flagg (P–Began June—3 parts to date—30 cts. each).

13708. Heating in the Wainwright Building, St. Louis, Mo. Ill. (E R–Began June 17—3 parts to date—15 cts. each).

14608. House Ventilation. Ill. (I C B–Began July 14—Ended July 28—3 parts—30 cts. each).

14944. Soil Pipes. S. Stevens Hellyer (E R–Began Aug. 5—1 part to date—15 cts).

14966. The Treatment of Malarious Localities by the Sanitary Engineer (I E–Began July 8—1 part to date—45 cts).

STEAM ENGINEERING.

*14225. The Analyses of Engine Tests. Editorial (Eng L–June 30.) 3500 w.

14227. The Comparative Costs of Feed Waters (E N Y–July 8) 1400 w.

†14311. Discussion of and Addition to R. C. Carpenter's paper on "The Variation in Economy of the Steam Engine Due to Variation in Load" (T A I E E–June & July.) 3500 w.

14337. The Bethlehem Hammer. Ill. (Ir Age–July 13.) 3000 w.

14391. Steam Domes.—The Proper Method of Constructing Them. Ill. (B J C–July 15.) 2000 w.

14423. Tests of Steam Boilers in the Chelsea Electricity Supply Company's Station. Ill. Frank King (S V–July 15.) 800 w.

14493. Power Steam. D. (M N–July 15.) 2000 w.

14523. Test of a Non-Condensing Engine under Various Loads. Ill. (E R–July 22.) 700 w.

14524. Barrus' Universal Calorimeter. Ill. (E R–July 22.) 900 w.

14531. Compression and Jacketing.—The Uncertainty Concerning Their Economy (B J C–July 22.) 1800 w.

*14583. Experiments on the Transmission of Heat Through Steel Plates, from Heated Gas at the One Side, to Water at the Other. A. Blechynden (I C T–July 14.) 2000 w.

*14592. Figures for Steam Users.—Water Area in Steam Boilers. W. H. Booth (E L-July 14.) 1350 w.

14618. How the Threshing Engine Can Be Improved. G. E. Smith (S E-July 1.) 700 w.

14626. Safety Device to Prevent Dangerous Racing of Corliss Engines. W. M. Stine (E E N Y-July 26.) 600 w.

*14677. The Parsons' Steam Turbine. Abstract of a Report by A. B. W. Kennedy (El-July 21.) 1600 w.

*14711. Boiler Feed Pumps (M W-July 21.) 2000 w.

14733. Yea or No.—Use of Dampers (M G-July 29.) 800 w.

14752. Troubles with Injectors.—Why They Occasionally Fail to Work (B J C-July 29.) 1300 w.

14770. The Smoke Problem in St. Louis. Editorial (A S-July 29.) 700 w.

*14773. Boilers and Furnaces. Ill. Angus Sinclair (L E-Aug.) 2200 w.

14781. Steam Engine Indicator.—Applying the Instrument. Ill. (P S-Aug.) 1450 w.

14830. Feed Heating in a Condensing Engine. W. H. Booth (A M-Aug. 3.) 1000 w.

14863. Standard Flanges. Ill. E. P. Bates (S E-July 8.) 1500 w.

14864. The Pantograph for Reducing Motion for Indicator. Ill. (S E-July 8.) 1000 w.

14907. Stop Motions.—Their Use and Abuse. W. H. Wakeman (M G-Aug. 5.) 900 w.

14917. External Furnaces for Upright Boilers. Ill. (B J C-Aug. 5.) 700 w.

14955. Boilers and Their Care. Mill Iron (A S-Aug. 5.) 700 w.

Serials.

11138. Notes on the Steam Injector. Strickland L. Kneass (E M—Began March—6 parts to date—30 cts. each).

11720. Steam Boilers. James F. Hobart (T-Began April 1—5 parts to date—15 cts. each).

12377. Steam Shovels and Steam Shovel Work. Ill. E. A. Hermann (E N-Began April 27—9 parts to date—15 cts. each).

13033. Practical Hints to Boilermakers and Templaters. Ill. (M W-Began May 12—2 parts to date—30 cts. each).

*14040. The Steam Engine (T-Began July 1—3 parts to date—15 cts. each).

14271. Chemistry of Boiler Incrustation. Harry Sylvester (P Eng-Began June 30—Ended July 14—3 parts—30 cts. each).

14356. Smoke Prevention (M R-Began July 14—2 parts to date—15 cts. each).

14908. The Testing of Boiler Plates. Ill. (M G-Began Aug. 5—1 part to date—15 cts).

TELEPHONY AND TELEGRAPHY.

*14220. Disturbances of Telephone Lines by Electric Railways and Their Remedies. Editorial (E L-June 30.) 1800 w.

*14221. "Telephone Lines and Their Properties." Review of book by W. J. Hopkins (E L-June 30.) 2500 w.

*14259. The National Telephone Company v. The Electrical Industry. Editorial (El-June 30.) 1600 w.

14286. Telephony vs. Electric Traction in England (E R N Y-July 15.) 900 w.

14327. Introduction of Telegraph Wires into Offices, with Special Reference to Line or Way Offices. E. R. Adams (E A-July 15.) 1600 w.

*14555. The Electrophone. Ill. (I & I-July 14.) 1000 w.

*14729. Telephones v. Electric Traction. Editorial (E-July 21.) 4500 w.

*14744. Preece's Improvements in Submarine Telegraph Cables. Ill. (E R L-July 21.) 500 w.

14796. Bell's Radiphone. Ill. (E W-Aug. 5.) 1600 w.

MISCELLANEOUS.

*14207. The Growth of Commerce on the Great Lakes. H. C. Pearson (E Mag-Sept.) 3000 w.

*14211. The Real Condition of the Farmer. George E. Roberts (E Mag-Sept.) 3000 w.

*14216. The Four Benevolent Giants. Thomas D. Lockwood (W F E E-July.) 3000 w.

*14238. The Use of Oil Fuel and Its Attendant Advantages. Edwin N. Henwood (E G-July.) 900 w.

14293. Hot Water Heating (A Ar-July 8.) 2600 w.

14300. Keeping Records of Contractor's "Extra Work" (E N-July 13.) 600 w.

14301. How Best to See the World's Columbian Exposition. Editorial (E N-July 13.) 2500 w.

14302. The First Two Fires at the World's Columbian Exposition (E N-July 13.) 1200 w.

14350. List of Papers for the Engineering Congress (R G-July 14.) 1000 w.

†14354. Crude Rubber—Rubber in the Caquetá Region of Colombia. Florentino Calderon Reyes (I R W-July 15.) 1100 w.

14355. Some Practical Aspects of the Southern Immigration Problem. N. B. Johnston (M R-July 14.) 1600 w.

*14360. Daubrée on the Geological Work of High Pressure Gas (N-July 6.) 3000 w.

†14364. The Teaching of Civic Duty. James Bryce (C R-July.) 6000 w.

†14366. Advance of the United States During One Hundred Years. D. Brock (F R-July.) 9000 w.

†14373. The Progress of Economic Ideas in France. Maurice Block (An A A-July.) 11000 w.

†14374. The Relation of Economic Study to Public and Private Charity. James Mavor (An A A-July.) 8000 w.

†14375. The Monetary Situation in Germany. Walther Lotz (An A A-July.) 6500 w.

†14377. On the Use of Silver as Money in the United States. Arthur B. Woodford (An A A-July.) 15000 w.

14385. Our Immigration Laws. What They Are and What Changes Should Be Made in Them. Robert DeC. Ward (B C-July 15.) 3200 w.

*14397. Workmen's Exhibitions. Editorial (E-July 7.) 2000 w.

14425. The First American Money Panic (M I T-July 13.) 1800 w.

*14457. Thomas Ruthven and Vandyke (A L-July 7.) 2800 w.

14478. The Cold Storage Palace at the Columbian Fair and Its Destruction by Fire. Ill. (Sc A-July 22.) 1000 w.

14501. The Congress of Aerial Navigation (E N-July 20.) 1450 w.

14521. The Ship Canal Through the State of New York. Editorial (E R-July 22.) 600 w.

14535. Peat as Fuel (E M J-July 22.) 750 w.

*14542. Types and People at the Fair. Ill. J. A. Mitchell (Sc M-Aug.) 2700 w.

*14543. The Lady of the Lake.—At the Fair. Julian Hawthorne (L Mag-Aug.) 4300 w.

*14548. The Permeability of Glass (E-July 14.) 1500 w.

†14620. India's Action and the Sherman Law. Horace White (F-Aug.) 3300 w.

†14622. Danger in Hasty Tariff Revision. Rafael H. Wolff (F-Aug) 3000 w.

14625. Electrical Engineering at McGill University, Montreal, Can. Ill. (E E N Y-July 26.) 2000 w.

14645. Ancient Glacial Moraine and Drift at the Mouth of the Columbia River. Ill. W. Hampton Smith (Sc A S-July 29.) 1500 w.

*14655. Lessons in Power from the World's Fair. Louis H. Gibson (S-July.) 1200 w.

14664. Public Comfort at Chicago and Philadelphia (E N-July 27.) 3500 w.

14686. Hard Rubber as an Insulator in Electric Railway Work. W. R. Mason (W E-July 29.) 1000 w.

14691. The Best Policy for the Silver Men. Editorial (E M J-July 29.) 600 w.

14724. Peat as Fuel (A G L J-July 31.) 900 w.

†14757. The Present Crisis. James H. Eckels (N A R-Aug.) 4000 w.

†14758. After the Four-Hundred Years, What? Sylvester Pennoyer (N A R-Aug.) 2000 w.

†14760. Anglo-Saxon Union: A Response to Mr. Carnegie. Goldwin Smith (N A R-Aug.) 6000 w.

*14762. Notes on the Proper Critical Attitude Architects and Engineers Should Assume in Attending the World's Fair, with Discussion. Charles W. Hopkinson (J A E S-June.) 4500 w.

†14767. Contemporary Japanese Art. Ill. Ernest Francisco Fenollosa (C M-Aug) 1500 w.

*14866. Ben Nevis and Its Observatory (Eng L-July 28.) 2200 w.

*14924. A Week in the Wilds. John Richards (I S F-Aug) 3500 w.

†14925. The Recently Found Castoroides in Randolph County, Indiana. Joseph Moore (A G-Aug.) 2000 w.

†14926. A Critical Notice of the Stratigraphy of the Missouri Palaeozoic. G. C. Broadhead (A G-Aug.) 4000 w.

†14927. The Three Fossil Placoderms of Ohio. E. W. Claypole (A G-Aug.) 3200 w.

†14929. Notes on Some of the Fossil Corals Described by David Dale Owen in His Report of Work Done in the Autumn of 1859, with Observations on the Devonian Species, Phillipsastrea Gigas of Later Authors. Ill. Samuel Calvin (A G-Aug.) 1200 w.

14952. Domestic Hot-Water Supply. Ill. F. Dye (A Ar-Aug. 5.) 1400 w.

14953. What is Heat? Henry W. Wilson (A Ar-Aug. 5.) 1700 w.

†14967. Poona Civil Engineering College. An ex-Student (I E-July 8.) 2000 w.

14983. Some of the Abuses of Brushes and Their Remedies. John J. Whelen (Sc A S-Aug. 12) 1000 w.

14985. The Behring Sea Fisheries. Ill. (Sc A S-Aug. 12.) 5500 w.

Serials.

9401. World's Columbian Exposition (E N-Began Jan. 5—19 parts to date—15 cts. each).

11821. Causes of Fires. C. John Hexamer (J F I-Began April—3 parts to date—45 cts. each).

13408. Scraps from an Engineer's Note Book (A M S-Began April 22—3 parts to date—30 cts. each).

13620. One Way to See the Exposition. Ill. Fred DeLand (W F E E-Began June—2 parts to date—30 cts. each).

13905. From the Centennial Exposition to the World's Fair. Thomas D. Lockwood (E W-Began July 1—3 parts to date—15 cts. each).

13998. The Future of the Hot-Air Furnace. A. W. Glessner (Met W-Began July 1—6 parts to date—15 cts. each).

14236. The Science of Success. George W. Buckwell (S L-Began July—2 parts to date—30 cts. each).

14545. American Universities at the Columbian Exposition (E-Began July 14—2 parts to date—30 cts. each).

14653. Theory vs. Practice. W. M. Patton (S-Began July—1 part to date—30 cts).

14742. Woven Wire and Segregation. Bryan Concoran (Inv-Began July 22—2 parts to date—30 cts. each).

14792. The Steering of Balloons. Ill. Rudolphe Soreau (A E R J-Began Aug.—1 part to date—30 cts).

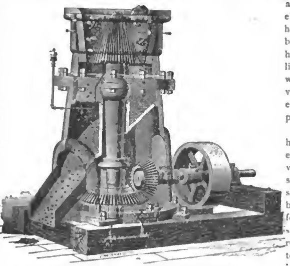
14878. Linen and Invention (Inv-Began July 29—1 part to date—30 cts.)

IMPROVED MACHINERY.

The matter published in this department is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

The National Rock Crusher.

A MACHINE which has been making an enviable record in a variety of work during the past year, is the National Rock and Ore Crusher, made by the National Machinery Co., of Tiffin, O., U. S. A. We give here a sectional view, which will go far to explain itself. It will be observed that the machine is constructed upon the gyratory, or continuous process principle. The action of the eccentric upon the ball bearing produces a gyratory motion around the concave, which space is entirely filled with stone, by reason of this the crusher head is doing duty at every point in revolution of the pulleys and gears, causing no shock or jar to the machine, the product pouring out over the diaphragm in a continuous stream, the capacity depending upon the size of the machine. The adjustment for size of stone is easy and rapidly obtained from the jack screws. The bottom of the shaft always remains in its eccentric oil chamber, and avoids having to get under it to change the size.



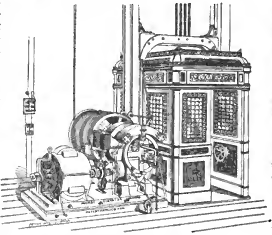
THE NATIONAL ROCK AND ORE CRUSHER.

The special points claimed in its favor are, (1) the position of the fulcrum below the head instead of at the top of the head, thereby giving greater power and leaving the concave entirely open for the reception of stone, which can safely be estimated to be a gain of 20 per cent in product over all others, besides dispensing with one or more attendants in feeding. (2) It does not pass spalls as is the case with reciprocating machines, or in fact, other gyratory machines. (3) The action of the eccentric upon the ball bearing produces a greater throw at the top of the crushing head than at the bottom of the head, resulting in gradually diminishing the size of the stone, whereby it is delivered at a more regular and uniform size than any other machine on the market. The manufacturers have just issued a new catalogue, giving detailed information as to the construction and practical work of the machine, and they will be pleased to mail a copy free of cost upon request.

A New Direct Electric Elevator.

WE illustrate in the accompanying engraving a direct electric elevator which has very recently been introduced by Morse, Williams & Co., the well known elevator manufacturers of Philadelphia.

The Machine has been designed especially with a view to obtaining simplicity of construction, accessibility of parts for repair, and smoothness in running, the latter exceedingly important feature being attained by the use of the improved Hindley worm gearing, the manufacture of which the firm has made a specialty for years. The motor is attached to the worm-shaft by means of a coupling. The worm-shaft is provided with a powerful double shoe brake, which is released by the action of an electro-magnet and is applied by a weight. The special advantage of this arrangement is shown in case the electric current from any cause be cut off, as the brake would be instantly applied, thus stopping the machine. The brake is so constructed as to act as a governor in checking the descent of the car, should it be accelerated beyond the normal speed at which the motor is designed to run it. This style of brake gives the machine great superiority over those dependent on the mechanical brake. The drum upon which the cables wind is grooved in the lathe and keyed fast to the heavy shaft, to which the worm-wheel is also keyed. This shaft is provided with stop collars and nuts, arranged to stop the car at terminal landings independent of the operator. The slack cable stop arrangement is also a feature of this machine; it stops the machine automatically in case the car should become obstructed in its descent and stop. Without such an attachment there would be an unwinding and consequent entanglement of the cables with the machinery. The motor is of the low speed, multipolar type; the bearings are self-oiling; carbon brushes are used, requiring a minimum of attention. The reversing switches and controlling apparatus are of simple and improved forms, their action causing the elevator to start easily and gently with and without a load. The efficiency of the machines has been tested under varying conditions, and the makers claim that the average amount of current consumed has been found to be lower than any Direct Electric Elevator in the market. For circulars or further details address the makers.



A NEW DIRECT ELECTRIC ELEVATOR.

A New Drill Chuck.

THE well-known chuck manufacturers, Messrs. E. Horton & Son Co., Windsor Locks, Conn., U. S. A., have lately added another to their long list of standard drill chucks. The engraving in their advertisement on page 66 shows it assembled and holding the drill ready for work, and in the one on the opposite page (27) the separate parts are shown.

It is simple in construction, very strong, and durable in all of its parts. The body is one piece of metal, and the entire chuck of but four pieces. It is made entirely of steel, and the jaws thoroughly hardened. The latter are so formed that the teeth in biting come opposite each other, so there is no danger of breaking or crimping the drill by the grip of the jaw, as in many chucks of this class. The right and left hand screw which drives the jaws, are set deep into the latter, so that more of an end thrust with the jaws is obtained, and consequently a stronger grip. The jaws are cylindrical, and the power of the screw being applied more directly, there is no binding or canting of the jaw when taking a short bite,—a fault with many two-jaw chucks made with the old fashioned angular jaw set in a rectangular slotted body. Circulars on application.

An Immense Dredging-Hose.

THE illustration on the page opposite this represents a fifteen-foot section of eighteen inch (internal diameter) smooth-bore dredging-hose, manufactured by the New Jersey Car Spring & Rubber Co., of Jersey City. A relative idea of the size of this immense hose may be gained by comparing it with the workman who has lost himself in its capacious depths—a man weighing 160 pounds. The company are especially equipped for doing this heavy class of work, or in similar lines, and no order in this direction can be beyond their capacity. Only the highest quality and heaviest grade of materials can be used, and the spiral coil of iron is over one inch in diameter. The hose is used on mammoth pumps for pumping sand, gravel, mud, etc., generally employed on U. S. Government work in broadening channels, deepening rivers and removing sand-bars that obstruct navigation. The bar at Sandy Hook was removed by this process and with similar hose.

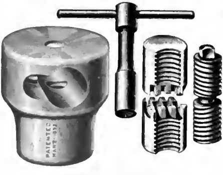
Notable World's Fair Exhibits.

A DISPLAY which every machinist and machine-shop operator who visits the fair should make it his business to examine, is that of the Cleveland Twist Drill Co., of Cleveland, Ohio, U. S. A., Space 29, Row L, 50, Machinery Hall. The space is less than the firm had planned, because the management of the Exhibition cut down their application to just one-half the room asked for. But they have exhibited a full line of all the goods manufactured, by giving only a few samples of each style of tool.

The goods on exhibition are exactly like their actual stock, in regard to finish and quality, and no extra finish or polish was put on any of the goods for exhibition purposes. They reasoned—very rightly—that the practical man who uses and handles such tools would like to see exactly what they are furnishing, and it would only be a great disappointment to such a man if highly polished goods were exhibited, and then orders filled with something inferior. A competent attendant is always at the stand, and a cordial invitation is extended to all visitors.

SECTION OF AN IMMENSE DREDGING-HOSE.

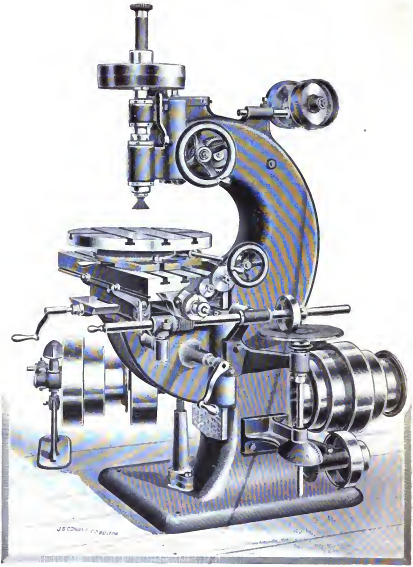
Another exhibit which must be classed among the most interesting and instructive at the Exposition, is that of The Stilwell-Bierce & Smith-Vaile Co., of Dayton, Ohio. It embraces Victor turbines of both "Register Gate" and "Cylinder Gate" patterns, arranged on both vertical and horizontal shafts, and ought not to be overlooked by any one who is using or contemplating the use of water power. These celebrated turbines are built in such great variety as to meet the requirements of almost any situation. Another very interesting feature of the exhibit is the Stilwell "open" and "close" Heaters, and the Live Steam Purifier for heating and purifying feed-water for steam boilers. The practical efficiency of these Heaters is demonstrated by a display of lime deposits taken from Heaters in operation in various sections of the country. The proper treatment of feed-water is an item of great moment in designing an economical steam power plant, and should be carefully investigated. This exhibit also contains a display of "Smith Vaile" steam Pumps in great variety and for every duty, thus increasing the practical value of the exhibit to all visitors who are making investigations along these lines.



A NEW DRILL CHUCK.

Not content with making one of the most effective and valuable exhibits in the Mines and Mining Building, the M. C. Bullock Mfg. Co., of Chicago, have issued most attractive "Columbian Circulars," illustrating and describing their display, and, closing their city office on So. Canal street, have transferred the entire staff to the Fair Grounds, thereby making their regular office at the exhibit, so that they may the better welcome and entertain their friends. In "Columbian Circulars" 24 and 25 they briefly describe and illustrate seven of their Diamond Drills, the "Champion" Ventilators, Band Friction Hoists, and the "Monarch" Rock Drills, giving table of capacities and powers of the seven sizes in which the latter are manufactured. Among the Diamond Drills there are several new types and styles. These have been brought out to fill special requirements of customers, and although the new machines have been in the market for the past two or three years, this is the first time they have been advertised or illustrated.

In the main aisle of Machinery Hall, section 28, Column K, 38-40, Messrs. Hill, Clarke & Co., Boston-Chicago, have one of the most extensive and instructive exhibits of machine tools

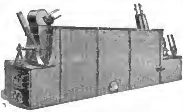


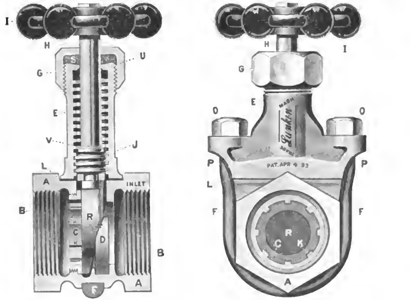
THE BECKER VERTICAL MILLING MACHINE, NO. 4.

to be found in the building. They are selling agents for several of the foremost tool makers in the United States, and for that reason their display embraces a variety which could not be drawn together otherwise. The result is an aggregation of notable productions which warrants the attention of every practical man who visits the Exposition, for one cannot fail to be profited by an examination of the display. They have also been thoughtful enough to issue a beautiful little catalogue illustrating the exhibit, which they will take pleasure in mailing on request.

Becker Vertical Milling Machine.

THE many new features and improvements embodied in the Milling Machine, illustrated on page 28, promise well to secure it representation in every machine shop where a milling machine can be of any use at all. In comparison with the ordinary horizontal spindle miller, it will be found a more valuable tool in the jobbing machine shop, owing to its remarkable changeability, performing as it does nearly all the various kinds of work usually done on the horizontal spindle, and of incalculable value on many other jobs where the latter is of no use whatever. It well meets the requirements of most of the boring and drilling done in a job shop. The rotary attachment has a circular table 20 inches in diameter, and is provided with T slots. It may be rotated by hand, or through connections with the power screw feed. A clutch on the main screw will throw the feed of screw in or out. When not required, the rotary power feed connections may be dropped down out of the way. Work 32 inches in diameter can be made to swing on the circular table, so that large apertures up to over 25 inches in diameter may be milled on rotary feed.


THE CUMMER DRYER.



THE NEW LUNKEN GATE VALVE—WM. H. LUNKEN INVENTOR.

The spindle driving pulley is 12 inches diameter, 3 inches face, independently mounted upon an adjustable anti-friction bearing, by means of which the spindle is kept in alignment with the table, is relieved from the one-sided action of the belt strain, and its bearings prevented from overheating and from wear. The importance of this feature to a Vertical Spindle Miller is such as to place this type of machine in the front rank as a superior tool for all purposes which a milling machine is adapted for.

There are many other advantages, too numerous for mention here, but they are fully covered in a very complete circular which will be sent on request by the manufacturers—John Becker Manf'g Co., Fitchburg, Mass., U. S. A.

The Cummer Dryer.

WE present in the accompanying illustration an exterior view of a machine which has made a very remarkable record in drying sand, clay, ochres, marl, ores of all kinds, infusorial earth and materials of kindred nature. Also for calcining ores of all kinds, gypsum rock, making plaster paris, paint stocks, clays, etc. Materials can be not only dried but also heated uniformly to any temperature between 150° and

1000°; and by the use of the same firm's calcining machine and apparatus, materials can be heated to exceedingly high temperatures. It is built by the F. D. Cummer & Sons Co., of Cleveland, Ohio. The machines are manufactured in a variety of styles suitable to various purposes, and in connection with them the same firm manufactures separating machinery and apparatus, calcining apparatus, chill rolls, rock crushers—in short everything in the way of machinery necessary to the work of handling ores and materials that require drying and other treatment. Each and all of their machines is the result of practical experience in the work of which they make a specialty, and for that reason their apparatus has attained a very high reputation among users. Referring to the machine which we illustrate, the firm says "The features of our furnaces are as valuable as those of the dryers, and the combined result is that we are able to do a very large amount of work with a very little fuel. In addition, while most revolving shell dryers last usually less than a year and need frequent repairing, we are safe in saying that ours will last five years, because they *have* lasted that long. In fact all the principal parts of the Cummer Dryer should and will last an ordinary life-time if reasonable care is given to the machine." When used in connection with the proper process, it dries very sticky or plaster materials like marl, very wet, stiff, and sticky clays of all kinds, including ochres, slacked lime, and like materials, carrying as high as 60% of water, without affecting color or cohesion.

A complete descriptive circular, giving full details as to all their machines, together with testimonials from numerous persons who have used them, is issued by the firm for the information of intending purchasers; and it will give them pleasure to mail it free on request. The matter of handling materials in this way has become a business in itself, and owing to the substantial advances accomplished by this firm in the construction of these machines, it will pay intending purchasers to investigate their apparatus.

The "Lunken" Gate Valve.

IT is well known by intelligent steam-users, that the ordinary Globe Valve, on account of its crooked and cramped passage, causes a great loss through resistance; and this accounts for the increasing use of straightway or Gate Valves many forms of which have attained widespread use. But there is not to-day a valve on the market (either globe or gate) in which the seat is practically renewable; and in case the seat becomes cut or much worn the renewal of the complete valve is necessary. This prompts the question, why should a valve shell when once in place not last as long as the pipes connected thereto? Why should the parts that wear (seat and disk) not be easily renewed? It is to meet precisely these essentials that the valve here illustrated (p 29) has been introduced. It is the invention of Mr. Wm. H. Lunken, whose reputation as an inventor is already established, since he is the originator of all the celebrated specialties manufactured by the Lunkenheimer Co., of Cincinnati, Ohio. The advantages claimed for it have been aptly expressed in this fashion:

"A valve whose SEAT (also disk) is renewable without disconnecting from pipes."

"A valve whose disk is balanced, thus operating easily, regardless of high pressure."

"A valve such as all users have thought a necessity."

The complete details as to these claims are very clearly set forth in an excellent illustrated circular, which the manufacturers will be pleased to supply on request. Beyond what our illustrations show, it is only necessary to say here, that within a few minutes and with perfect ease, any person can practically make a worn out "Lunken" Gate Valve as good as new, the cost of the renewable seat or a new disk being a trifle. Another important feature is, that the stem, when the valve is full open, seats itself, thus relieving all pressure on the stuffing-box, and permitting repacking of the latter under pressure. It is impossible for anything to lodge on the seat of this valve, because the seat and disk have a parallel straight face, and as the pressure on the back of the disk keeps it tightly pressed against its seat, it actually cuts away anything in its path. This feature, combined with the renewable seat, commends this valve for blow-off purposes.

The Lunkenheimer Company, of Cincinnati, after having experimented with and tested these valves for the past six months, on pressure exceeding 150 pounds, are now busily at work getting out valves in brass from 1/4" to 3", and iron with screwed ends from 2" to 12", and expect in a few weeks to be ready to take orders. Owing to the importance and scope of this invention, they are also arranging with several other prominent manufacturing firms to produce these valves on a large scale. Propositions and investigation of manufacturers interested, for American or Foreign rights, are solicited. The firm has a large exhibit at the Chicago World's Fair, Machinery Hall, Section 25, Column O-24, where visitors can see samples of the "Lunken" Gate Valve.

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